External Letter Peer Review of Report on PCB Caulk in New York City School Buildings

Final Report

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Task Order #23

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Introduction

Background

Polychlorinated biphenyls, or PCBs, are man-made chemicals that persist in the environment and were widely used in construction materials and electrical products prior to 1978. Although Congress banned the manufacture and most uses of PCBs in 1976 and they were phased out in 1978, there is evidence that many buildings across the country constructed or renovated from 1950 to 1978 may have PCBs in the caulk used in interior and exterior locations, sometimes at high concentrations. Other sources of PCBs, such as fluorescent light ballasts, adhesives, paints, and mastic may also be present in buildings. Exposure to these PCBs may occur as a result of their release into the air, dust, surrounding surfaces and soil.

The PCBs in caulk, adhesives, paint and mastic (that are at levels greater than or equal to 50 ppm) are not authorized for use under the Toxic Substances Control Act (TSCA). While TSCA regulations do not require building owners to test for PCBs, if testing of these building materials shows PCB concentrations at or above 50 ppm then the PCBs must be properly disposed of, in accordance with 40 CFR 761.62. The PCBs in non-leaking, intact ballasts are an authorized use and may be disposed of in a properly permitted solid waste landfill. Ballasts containing PCBs which have leaked must be disposed of in a properly permitted hazardous waste landfill or incinerator. Materials contaminated by PCBs that have leaked or migrated from the aforementioned regulated building materials must be disposed of in accordance with 40 CFR 761.61.

New York City (NYC) has conducted a remedial investigation/feasibility study at five NYC schools to evaluate alternative means of dealing with PCB-containing caulk in their schools. The investigation has demonstrated that the PCB-containing caulk is but one of several PCB sources. Emissions of PCBs from caulk and leaking ballasts in light fixtures have also contaminated a wide range of other building materials, which may be re-emitting PCBs into the air. It has also been demonstrated that many areas in the schools are inadequately ventilated.

Approximately 1 million school children are exposed to PCBs from caulk, light fixtures, and secondarily contaminated materials. The removal and replacement of the light fixtures alone from approximately 750 NYC public schools has been estimated by NYC to cost approximately 800 million dollars. Given the large stakes involved, it is important that the best long-term solutions are identified and implemented.

Peer Review

Under an existing contract, the U.S. Environmental Protection Agency (EPA) tasked Eastern Research Group, Inc. (ERG) with organizing an independent external peer review to evaluate the effectiveness of the Preferred Citywide Remedy as presented in the *Summary Report for the New York City School Construction Authority Pilot Study to Address PCB Caulk in New York City School Buildings*, prepared by TRC Engineers.

ERG conducted a search to identify 10 experts who collectively had the following expertise and who had no conflict of interest (COI) in performing this review (as verified in a signed COI analysis form):

- Exposure and health risk assessment
- Exposure assessment methodologies (ingestion, inhalation, dermal exposures)
- Statistical analysis of data
- PCBs in building materials (caulk, adhesives, paint, mastic, ballasts)
- Remediation technologies for PCBs in buildings

Upon EPA confirmation that the pool of candidate reviewers met the technical selection criteria, ERG selected three reviewers who collectively provided the optimal expertise to address all peer review charge questions.

ERG provided the experts with instructions, the summary report, background documents, and a technical charge prepared by EPA. ERG notified reviewers that they should not share the review materials or consult with anyone during the review process. Reviewers were given approximately three weeks to conduct their review. They provided their individual written comments to ERG who forwarded them to EPA.

This report provides a record of this peer review. It includes:

- Reviewers' responses organized by charge question
- Individual reviewers' comments (Appendix A)
- Charge to reviewers (Appendix B)

Responses to Charge Questions

1. Does the Summary Report dated May 24, 2013 clearly and comprehensively describe the sources, environmental levels, and potential exposures for PCBs in school buildings?

Reviewer	Comments
Reviewer 1	The Report presented information on the sources, environmental levels, and potential exposures in such a fashion that I could develop an understanding of each at the respective school buildings. I understand that this is a summary report and relies on information presented in previous reports, specifically the Remedial Investigation Reports (RIRs); however, the sequential presentation of data was somewhat confusing and I needed to review both RIRs in detail prior to understanding the Summary Report presentation. References to data tables in multiple reports and appendices was also not easy to follow as compared to an overall summary table of data by school, room, and date (including remedial action) for each environmental media, which would have been helpful. In addition, the author's may want to consider presenting the data and results by school instead of by activity because in the end many different remedies/activities were conducted at each school in addition to the primary remedy under evaluation. It was difficult to draw an overall conclusion on the effectiveness of the specific remedy because many different activities were conducted in response to lowering the indoor air levels. If there were specific rooms where only a patch/repair or encapsulation was conducted and no light ballasts removals or cleaning or ventilation changes completed, then a specific evaluation of that remedy/activity could be performed in the context of the remedy objectives (as a standalone remedy); if this condition was evaluated is was not clearly explained in the report for each school. For example, at one school (P.S. 3R), the report discussed the results of indoor air concentration reduction in a stairwell that was attributable to a PCB caulk repair and encapsulation event (page 43 of the Final RIR); this finding is specific to removal action and was helpful in determining the potential effectiveness of the remedial option.
Reviewer 2	The Summary Report does not provide a concise comprehensive description of the sources, environmental levels, and potential exposure for PCBs in school buildings. It attempts to achieve this objective by referencing the EPA PCBs in School Buildings report and extraction of some information/data from thereof. A few summary paragraphs such as those in Section 5.1 of the EPA PCBs in School Buildings report would be very informative. The summary paragraphs would be best suited for inclusion in Section 1.2 "Background" of the May 24 report. Although the NYC school buildings were inspected for other primary sources of PCBs (i.e., fluorescent light ballast), it is uncertain whether mastics used to adhere thermal insulation to exterior of ventilation ducts were considered, which could be a significant source of PCBs in buildings. If this is applicable to the school buildings, please consider the information contained in the following paper: Kominsky, JR. *PCB-Containing Adhesive in Ventilation Ducts: A Significant Source of Contamination in an Office Building*, Proceedings U.S. EPA Symposium Engineering Solutions to Indoor Air Quality Problems, July 17-19, 2000.

Reviewer 3	The description of sources, environmental levels, and potential exposures for PCBs in school buildings presented in the Summary Report (the report) dated May 24, 20134 is written fairly clearly in that information is presented in sections that are of reasonable length and the language is accessible rather than heavy on technical jargon. Nonetheless, the clarity would be improved substantially if the report was organized differently and the language was more precise. At present, the report is organized in large part around three themes: (1) remedial actions, e.g., section 2.5; (2) types of sampling events, e.g., section 2.7; and (3) exposure interventions, e.g., section 2.8. This organization made it difficult for this reader to follow a 'thread' among the various sections of the report. As a result, the principal findings are not self-evident and in this sense the description of sources, environmental levels, and potential exposures is not clear at all. The clarity of the report would also be improved by adding more rigor to the descriptions of PCBs levels measured in exposure media. At present, the report most commonly provides the range of PCB concentrations measured during a sampling event. Additional information would be more informative, including measures of central tendency, such as the mean or median, and dispersion, such as the standard deviation. More information of this type is warranted given that the report makes a point of hypothesis testing in Section 2.1.2. In summary, the clarity of the report would be improved if organized in a consistent manner from section to section and if the report was more transparent about the quantitative findings from the large amount of sampling conducted. The description of sources, environmental levels, and potential exposures for PCBs in school buildings presented in the report would need to be expanded in order to be comprehensive. Readers are provided with information on PCBs in caulk and selected other media, including dust and certain surface finishes. However, little information is provided on any other potential sources, primary or secondary, including but not limited to waterproofing materials, adhesives, ceiling tiles, or insulation. The authors describe the results of a secondary source strength analysis that apparently was conducted by EPA. The results of the secondary source strength analysis are presented with little discussion of the associated uncertainty and little evaluation of its accuracy through testing. A critical review, and probably empirical assessment, of remaining sources in the schools would be helpful if the City wished to obtain a deeper understanding of strategies for effectively mitigating current exposures. In addition, the report does not clearly state the scope of the work – e.g., is the report focused only on the pilot schools or instead does it cover the population of public schools in New York City. Clarifying the scope of the report would establish the benchmarks for evaluating the extent to which the document is comprehensive.

2. Please comment on the appropriateness of the remedies selected. Do they provide adequate reductions of the exposure to PCBs? If not, do you have suggestions for additional reductions that could be achieved, given the available data?

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<tr><th>Reviewer</th><th>Comments</th></tr>
<tr><td>Reviewer 1</td><td>
I think the remedies that evaluated options for the caulking were appropriate (removal or encapsulation) with the exception that a decontamination or treatment remedial component could have been included. My experience with these decontamination/ treatment options is that they could have been integrated as a component into one of the remedial options evaluated and not as a standalone remedial option. For example, following caulk removal, the substrate could have been treated prior to applying the new caulking. The goal of the treatment step would be to reduce PCB concentrations in the substrate to limit the amount of PCBs available to migrate into the new caulking. It is acknowledged that existing PCB decontamination products are difficult to apply on vertical building surfaces or in narrow spaces, where caulking is typically applied, so the practicality of this step may only be available during larger scale renovation or capital improvement projects.
In my experience at multiple buildings, the phenomenon of recontamination of replacement caulking with PCBs is common and predicates the need for a secondary barrier to either:

isolate the PCBs into the substrate and limit/eliminate migrate into the replacement caulk;
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this can be reasonably accomplished by using a liquid epoxy on the substrate, allowing the product to cure, collecting wipe samples to verify PCBs have been encapsulated, and then applying the replacement caulk
isolate the PCBs from the encapsulating coating.
<ol type="a">
this can be accomplished by using a liquid coating (e.g., an epoxy) applied over the PCB-containing material as an initial encapsulant followed by the final coating for the surface, or by applying a non-liquid barrier (e.g., a metallic tape or similar material) over the PCB-containing caulking following by new caulking.

A typical sequence of remedial steps under a removal scenario that we have implemented at numerous building consists of:

Removal PCB caulk and residuals;
Optional step: decontaminate or treat substrate to reduce levels of PCBs in the substrate (limitations on product selection and timing of application in context of overall project work [e.g., a window replacement project]);
Apply secondary barrier, typically a quick-cure liquid epoxy, to the substrate to “seal” PCBs into the substrate
Apply new bead of replacement caulk

The BMPs appear to provide an appropriate level of inspections and corrective measures for deteriorating caulk and cleaning of surfaces. The Report makes it clear that the
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	cleaning practices typically implemented by the school staff result in limited PCBs on high or low contact surfaces and should be continued as stated in the Report. The BMPs do not address PCB caulk in good condition, although is not certain that PCB caulk in an intact non-deteriorating condition needs to be addressed in the near-term (see additional discussion/comments provided to other questions below). The focus on maintaining the HVAC and ventilation systems is appropriate and needed; however, refer to comments below on the effectiveness of the procedures with regard to achieving the goal of proper ventilation.
Reviewer 2	Overall, I agree that diligent implementation of the proposed multiple remedial measures to eliminate the primary sources of PCBs (caulking and fluorescent light ballast) will ultimately reduce inhalation exposure by school building occupants to PCBs below the EPA Public Health Guidance Values. Eliminating PCB-containing interior/exterior caulk as a primary source of PCBs in and around the school buildings is more problematic (and effective remedial measures are yet to be finalized) than eliminating the other primary source, PCB-containing fluorescent light ballasts. Although both sources must be resolved to achieve the ultimate goal, resources to eliminate the “low-hanging-fruit” (replacement PCB-containing ballasts) should be more aggressive. Implementation of the PCB-Containing Ballast/Fixture Replacement and Inspection/Response Action Program remedial measure in combination with increasing the volume of outdoor air would likely have an “immediate to near-term” impact on reducing the PCB exposure levels in the school buildings. Although the number of PCB-containing fluorescent light ballast present in the 645 school buildings nor the frequency of electrical-thermal failure of the ballasts are known, removal of these ballasts will likely have the greatest impact on the reducing airborne and dermal exposure to PCBs. A diligent interim inspection and ballast-failure response program will definitely reduce exposure to PCBs by school building occupants as well as reduce further PCB air/surface contamination levels in the buildings. A study conducted in the Seattle School District (1987)[1,2] showed levels of airborne PCBs that ranged from approximately 1,000 to 4,000 ng/m^3 and 700 to 1,200 ng/m^3 in classrooms seven and 34-days after ballast failure, respectively. Consider evaluating a hybrid approach between source modification (i.e., lowering the amount of PCBs in caulking through chemical degradation) and contact encapsulation (i.e., covering PCB-containing caulking with an impermeable sealant). Although both of these methods applied individually have documented limitations, in combination they may prove to be completely effective. Consider conducting efficacy trials for the sequential application of these methods. Performance over time and relevance to real-world conditions should be the focus of these trials.
Reviewer 3	More information is needed to answer this question. An answer requires first determining exposures to PCBs that are acceptable in terms of magnitude, duration, and frequency. EPA has suggested benchmarks for concentrations of PCBs in indoor air and regulatory

1 Kominsky, JR. PCB Contamination Resulting from Fluorescent Light Ballast Failure in Seattle Public Schools, NIOSH Report HETA-85-072-1980 (1987).

2 Kominsky, J.R. PCB Exposures Following Fluorescent Light Ballast Burnout. Applied Industrial Hygiene J. Vol. 2(3): R-23, 1987

	thresholds for PCBS in bulk materials and on surfaces. Those EPA benchmarks are reproduced in the report. However, this reviewer does not believe that the indoor air benchmarks have received a level of peer review that is typical of health protective guideline levels for chemical contaminants in environmental media established by EPA. Moreover, EPA recommends a site-specific analysis to support guideline values for a given building; site-specific analyses are not described in the report. Likewise, this reviewer does not believe the regulatory thresholds for bulk materials and surfaces are based on exposure scenarios for students, teachers, staff, and visitors in schools.

3. For each remedy: Does the remedy provide sufficient information to reasonably demonstrate the effectiveness of the proposed remedy? If not, what additional information is needed?

Reviewer	Comments
Reviewer 1	<u>Patch and Repair of PCB Caulk, Remove and Replace PCB Caulk, and Caulk Removal associated with Window Removal</u> These three remedies all involve the removal and replacement of PCB caulk. Given the PCB caulk is removed, the remedy is effective in eliminating the exposure and contamination from the PCB caulk, except in areas where only deteriorated caulk is removed (incomplete removal). The report indicates that these removal remedies are not effective given the re-contamination of the replacement caulk with PCBs from the underlying substrate. As indicated above, this condition could be addressed through the application of a secondary barrier (as it has been effectively completed at many sites within Region 1). As evaluated, the remedy conclusions appear correct; however, the removal remedy should not be removed from further evaluation given that an added step (secondary barrier) could be implemented to render the removal remedies effective in meeting the project objectives. <u>Encapsulation of PCB Caulk</u> The effectiveness and conclusions drawn from the Encapsulation Remedy were based on surface wipe samples collected using hexane-soaked wipes following standard surface wipe sampling procedures. However, the use of hexane, or any other aggressive organic solvent, on a porous media (paint/coating) over another porous media (PCB caulk) may not represent actual surface concentrations on the subject coating. Given the aggressiveness of the solvent and the porosity and organic nature of the coating, the solvent could be "pulling/extracting" PCBs from the PCB caulk and through the coating. In addition, hexane may also deteriorate or breakdown the coating itself. If this phenomenon is occurring, then the wipe samples may not be assessing PCB concentrations on the surface of the encapsulant and those available for dermal contact. If the intent of the encapsulation remedy is to coat/isolate the underlying PCB caulk in order to prevent dermal contact and dust generation, then the parties may want to consider a performance measurement method that emulates dermal/direct contact, such as a wipe soaked in saline (to emulate skin conditions), a dry wipe, or a wipe soaked in some other media/non-organic solvent. By applying an intact coating over the caulking, the objective of eliminating future dust generation appears to have been met, but this is not mentioned in the Report. One would think that the coating would also reduce the amount of PCBs subject to direct contact/dermal exposure given its presence; however, pre-application wipe tests are not provided to compare to the post-application wipe tests to evaluate this effect. <u>Removal and Replacement of Light Fixtures with PCB Ballasts</u> Given that PCB containing light fixtures will be removed, this remedy is considered effective in meeting the project objectives. It has also been shown that this remedy will also have an effect on reducing PCB concentrations in indoor air, if present.

	<u>Best Management Practices</u> The BMPs appear to provide an effective means for inspections and corrective measures for deteriorating caulk and cleaning of surfaces. The Report makes it clear that the cleaning practices typically implemented by the school staff result in limited PCBs on high or low contact surfaces and should be continued as stated in the Report. The BMPs do not address PCB caulk in good condition, although is not certain that PCB caulk in an intact non-deteriorating condition needs to be addressed in the near-term (see additional discussion/comments provided to other questions below). The Report establishes a linear relationship that exists between indoor air PCB concentrations and room air exchanges (i.e., PCB levels tend to decrease as room air exchanges increase). Ventilation systems in the pilot schools systems were found not to be operating at their design parameters and when adjusted/repaired, PCB levels in indoor air decreased. Given this relationship, more information should be provided in the BMPs in order to determine the effectiveness of this BMP. Specifically, how the ventilation systems will be tested, which data will be collected under different operating conditions (exhaust rates, air exchange rates, with windows opened or closed, etc.), and the frequency of testing to know/document if the systems are “operating per design” or at an appropriate level with regard to air exchanges per hour.
Reviewer 2	a. Fluorescent Light Ballast Response Protocol: A relatively simple and effective measure to reduce the air and surface burden of PCBs in the school buildings is upon awareness of a ballast failure (as characterized by “foul odor,” smoke, and/or asphaltic potting compound dripping from the fixture) <u>immediately ventilate</u> the incident classroom and/or areas. The current protocol permits the PCB-borne vapor/particulate to remain in the room and disperse for up to 48 hours; i.e., the Department of School Facilities (DSF) will dispatch an environmental response contractor within 48 hours of the custodial engineer reporting the condition. It is recommended that the protocol be revised to require that the custodial engineer vacate the classroom or area (if applicable) and immediately open all windows in the room or area (if present) and take any measure available (such use of a fan) to vent the room air directly to the outdoors and replace it with fresh air. Mechanical ventilation of the space is paramount to minimizing dispersion of airborne PCBs and absorption of the particulate/vapor-borne PCBs on surfaces. The “Re-Occupancy Protocol for Ballast Fluid Leakage outside the Fixture and Visible Smoke Emissions from Ballast/s” (dated April 23, 2013) specifies that the incident room is ventilated by 20 complete air changes. Is there an objective basis for specifying 20 completed air changes? Is there any actual or empirical data or information that supports the effectiveness of the specified air exchange rate? b. Section 4.3.2 of the Best Maintenance Practice (BMP) regarding HVAC System states that the heating stacks will be used to provide tempered fresh outdoor air to the school buildings. The corresponding anticipated increase in the air-exchange rate for each school building should be calculated and included in the summary report. The positive impact of the increased volume of outdoor air on reducing the indoor air concentrations of PCBs should be determined to understand its effectiveness. The effectiveness of this remedial measure could be determined in a few pilot buildings by collecting air samples both before and after using the heating stack to provide

	additional outdoor makeup air.
Reviewer 3	**Caulk Patch and Repair.** Yes. From experience and information, a patch and repair remedy is not likely to be effective at meeting applicable regulatory and normative benchmarks and this view is consistent with the findings described in the report. **Caulk Encapsulation.** No. The report makes no mention of whether or not a barrier was placed between the PCB caulk and the encapsulant material. Published literature and personal experience indicate that encapsulation is a reasonably effective remedial measure when a barrier such as polyethylene tape is placed between PCB caulk and encapsulant material such as a Sikagard product. **Caulk Removal and Replacement.** Yes. This method has been demonstrated to be ineffective elsewhere. **Window Replacement.** No. This method can be effective at reducing exposures to a substantive degree when PCB caulk is present on the interior face of window frames. More information on the disposition of the caulk around window frames is needed to evaluate this remedial alternative more fully. **Light Fixture Ballast Removal and Replacement.** Yes. This remedy removes a source of PCB emissions inside of schools and therefore is expected to be effective at controlling exposures to light ballast-related PCBs. **Best Management Practices.** No. Testing of PCB levels in indoor air and on surfaces in schools that have been subject to Best Management Practices and comparison to performance benchmarks is needed to determine the effectiveness of this proposed remedy. At the time of this report, Best Management Practices appears to have been identified as a preferred remedy based upon deductive reasoning rather than through empirical means. The report and its conclusions would be strengthened by an analysis of the assumptions that underlie the Preferred Citywide Remedy and the extent to which those assumptions and the findings from the pilot schools can be applied to the population of schools in New York City. In addition, because the Best Management Practices do not include proactive interventions, expect for the light ballast and ventilation components, the report would be strengthened by presenting an analysis of the number of schools at risk of exposure concentrations in excess of health protective benchmarks and the length of time for which those conditions would be expected to persist under the Best Management Practices program. **Cleaning.** Yes. From experience and information, a cleaning remedy is likely to have only limited effective at meeting applicable regulatory and normative benchmarks and this view is consistent with the findings described in the report. **Ventilation.** No. There is no question that ventilation with outdoor air is an effective means of controlling concentrations of PCBs in indoor air of schools. The means by which outdoor air can be delivered to a building and the amount of outdoor air supplied is determined in large part by the ventilation schemes in use or otherwise available for a given building. A wide variety of strategies is possible, a subset of which may be applicable to a given school. The report would need to include a matrix of ventilation modes in New York City schools and the corresponding ventilation strategies in order for the proposed remedy to be sufficient. **Carbon Filtration.** No. The remedy would need to include specific carbon filtration

	devices and replacement schedules to be sufficient. This information is important in order to address the inherent limitations of strategies based on sorbent media which include but are not limited to capacity and fouling by ubiquitous substances such as water vapor. **Exterior Sources.** Yes. From experience and information, remediation of soil is an effective means of controlling PCB levels in soil and this view is consistent with the findings described in the report. **Additional Comments.** See prior responses regarding controlling for effects of temperature and ventilation when evaluating the efficacy of remedies for mitigating PCB concentrations in indoor air.

4. For each remedy: Are the methodologies used consistent with the state-of-science? If not, please provide specific references and suggestions for revision.

Reviewer	Comments
Reviewer 1	With regard to the removal remedies and as described above in more detail, the use of a secondary barrier and treatment or decontamination methods for concentration reductions of the substrate should have been considered/implemented to fully evaluate these remedies. With regard to the encapsulation remedy, the use of other verification testing techniques (wipe extractants) should have been considered to fully evaluate the remedy. Overall, the post remediation indoor air samples were typically collected within a month or so of the remedy implementation. I understand the limitations of working over the summer months when school is not in session; however, this short timeframe may not have been enough time to address the effectiveness of the remedies (given the context of seasonal variabilities and other operating conditions). The reports do not comment on the amount of air exchanges or ventilation rates in the remediated areas prior to collecting the post remediation indoor air samples. Additional samples were collected in several schools at later times; however, these were in response to additional activities (cleaning, ventilation increases, etc.) in order to reduce the indoor air levels. As such, a specific "cause-effect" condition with regard to the specific remedial action implemented and its effect on indoor air concentrations over time is difficult to determine with the data collected/presented. I thought the Relative Source Strength (RSS) approach was a sound approach to focus the investigation and potential corrective measures within a room or school building. It would be interesting if the RSS was also calculated for the primary sources to assess their potential contribution.
Reviewer 2	Yes, the methodologies used are consistent with the state-of-science, as applicable.
Reviewer 3	To evaluate the efficacy of remedies for controlling indoor air concentrations of PCBs, investigations should account for effects of temperature on PCB emissions and ventilation on removal of airborne PCBs. Methods for temperature and ventilation control are described in the open literature (e.g., MacIntosh et al. 2012). The report makes no mention of controlling for temperature and ventilation quantitatively when comparing pre- and post-remediation air sampling results. Without controlling the indoor air sampling results for effects of temperature and ventilation, the robustness of the conclusions about the effectiveness of specific remedies for mitigating inhalation exposures is unknown. Additionally, see responses to the preceding question. MacIntosh et al., 2012. Mitigation of building-related PCBs in indoor air of a school. Environmental Health. 11:24. http://www.ehjournal.net/content/11/1/24

5. Do you have specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report?

Reviewer	Comments
Reviewer 1	The Report indicates that the Preferred Citywide Remedy will be integrated into a Citywide PCB Management Plan that will be phased in a prioritization approach. This makes sense given the number of subject schools; however, the Preferred Citywide Remedy should also have some prioritization components, as well, to focus the remedy within each of the schools. A couple of examples are provided below. The data presented indicates that 82% of the interior caulking samples reported PCBs < 50 ppm. I have seen this condition (interior caulking with lower levels of PCBs compared to exterior caulking) at many other buildings as well. This condition should be reviewed in the context of the assumption that all caulking at the subject buildings is a PCB caulk (i.e., ≥ 50 ppm total PCBs). An overall objective of this work should be to ensure that students and occupants of the building are protective from adverse exposures to PCBs. The BMPs have a process for addressing deteriorated caulking under the assumption that it is a PCB caulk. I have no comments or changes to this approach. However, with regard to intact caulking, the parties may want to consider a prioritization to address this caulk based on the potential for exposure, with the two main pathways being dermal contact and inhalation. Under both scenarios, the higher the PCB concentration, the greater the potential risk exposure; therefore, the parties may want to consider a screening approach to identify caulking that may contain higher concentrations of PCBs. I have successfully used chlorine (via an XRF detector) to screen caulking within a building and identify certain caulking samples that could have a greater probability of containing PCBs based on the chlorine concentration. With regard to dermal exposure probability, the higher screened caulking could then be screened based on accessibility to identify materials for some form of remedy or further assessment. For example, interior caulking between a metal door frame and CMU block is typically a narrow bead that is coated/encapsulated with a paint; this caulking would have a lower probability of direct contact given these conditions; and therefore may not need to be a focal point for a remedial action. Whereas, an uncoated caulking along a window sill used for classroom storage or other use may warrant some form of remedy or further assessment. With regard to inhalation, the higher the PCB concentration, the greater the potential for PCB emissions at higher concentrations; therefore, the higher probability caulking could be targeted for a remedy, further assessment, and/or for ventilation assessments and improvements if deemed needed to increase air exchanges (based on a review completed as part of the BMPs).
Reviewer 2	I have no specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report other than included some concise data summary tables as an appendix to the report. This would afford the reader a better understanding of the report without accessing the source documents.

Reviewer 3	The report would be more clear and comprehensive if it provided information on the amount of interior PCB caulk in each school – e.g., length, width, exposed area, weight, and coating (if any). Inclusion of photographs would be helpful for providing readers with the context needed to understand the disposition of PCB containing materials in the schools. The report would be stronger if expanded to clarify the PCB exposure benchmarks used to evaluate success of any given remedy or combination of remedies. A rationale and justification for the benchmarks should be provided. See above for other specific recommendations.

6a. Are there alternatives to the visual inspection protocol for detecting ballasts that have leaked?

Reviewer	Comments
Reviewer 1	I think that a direct visual inspection is an appropriate method to determine if a liquid leak has occurred. Other ancillary methods (wipe tests, etc.) would be difficult to predict if it was a result of a liquid leak or some other transport pathway. However, to completely ascertain if a liquid leak had occurred, the specific FLB should be inspected by opening the fixture.
Reviewer 2	Ballast burnout occurs when an electrical malfunction internal to the ballast (typically, a short circuit in the coil) causes a dramatic increase in internal temperature and ultimately ends with breaking the electrical circuit. The increased temperature causes the asphaltic potting compound in the ballast to melt and leak out. The odor associated with fluorescent light ballast burnout is typically associated with an odor that is characterized being “acrid,” “foul,” “electrical,”, or “burning asphalt.” Hence, detection of such an odor by a custodial engineer could be indicative of a recent or on-going electrical burnout of fluorescent light ballast. The Preferred Citywide Remedy states the “T12 fixtures are inspected on a regular basis by custodial staff…” To ensure consistency by the Custodial Engineers to implement this action define the term “regular basis;” e.g., the T12 fixtures are inspected at least once per week or whatever frequency is feasible. State the basis for selecting the frequency for inspecting T12 fixtures.
Reviewer 3	Yes. Air testing is an alternative to the visual inspection protocol. Air testing has the advantage of integrating emissions from all potential light ballast sources and therefore does not rely upon the ability of inspectors to identify evidence of a leak. Air testing would also detect emissions from sources other than light ballasts. The approach is therefore sensitive, but not specific. The report would be strengthened if the City articulated the relative weight or value it places on sensitivity versus specificity for the proposed and all alternative light ballast remedies.

6b. EPA has suggested revising the re-occupancy protocol to include post-cleanup air sampling in addition to the current practice of surface wipe sampling for PCBs. Is wipe sampling alone adequate to minimize exposure of students and staff to PCBs?

Reviewer	Comments
Reviewer 1	In response to your question, the answer would be no, wipe sampling alone is not sufficient to assess potential exposure from PCBs to occupants in a room. However, as the Pilot Tests indicated, there are multiple potential sources of PCBs to indoor air, in addition to PCB light ballasts. As the data showed, the removal of PCB light ballasts had the greatest effect on lowering indoor air concentrations. The next mitigation method was ensuring the room's ventilation system was operating properly and potentially increasing air exchange rates to flush residual indoor air. Given the potential for other contributing sources, I do not think that an indoor air test should be made part of the re-occupancy protocol as it relates to the re-occupancy of the subject room. Although, the room should be prioritized for a ventilation system assessment and screening (as described below) to assess potential inhalation concerns and stabilization measures, which may include indoor air monitoring.
Reviewer 2	Electrical burnout of in service PCB-containing fluorescent light ballast release PCB-borne particulate/ vapor that deposits on surfaces in the incident classroom/ area, as well as potentially on surfaces in other areas. The surface levels of PCBs (excluding surfaces directly impacted with asphaltic potting compound released from the fluorescent light ballast) range from non-detect (<0.1 µg/ 100 cm^2) to <3 µg/ 100 cm^2.(1) These surface contamination levels are higher than comparative background but are significantly lower than the U.S. EPA high occupancy surface wipe sample criteria (10 µg/ 100 cm^2). Hence, excluding the small isolated surfaces (e.g., desktop) directly impacted by potting compound that dripped from the fluorescent light fixture, the surfaces impacted by deposition of smoke particles in the room most likely will be consistently below the EPA occupancy surface criteria. Air sampling in classrooms that experienced showed that Elevated levels (800 to 1,200 ng/m^3) of airborne PCBs existed 34-days after fluorescent light ballast burnout in classrooms.(1) Air sampling would be a better metric to determine potential exposure risk to the occupants from incidents involving visible smoke emissions from fluorescent light ballast burnout. Air sampling would also provide quantitative data to evaluate the adequacy of ventilating the classroom/area with 20 complete air changes as specified in the "Re-Occupancy Protocol for Ballast Fluid Leakage outside the Fixture and Visible Smoke Emissions from Ballast/s," dated April 23, 2013.
Reviewer 3	If conducted appropriately, wipe sampling following clean up of surfaces that contained residual PCBs released from light ballasts should be sufficient for ensuring that exposures to light ballast-related PCBs identified by the visual inspection program are minimized. An appropriate wipe sampling program would be representative of the surfaces known or suspected to have contained light ballast-related PCBs. However, such a program may not be sufficient for ensuring that all PCB exposures associated with light ballast releases are minimized. For example, PCBs released from light ballasts are likely to migrate to other materials in a building as a result of

	volatilization and subsequent sorption. Those secondary source materials could lead to exposures that exceed City-specified exposure thresholds and therefore would warrant mitigation. Similarly, wipe sampling areas that formerly contained stains consistent with PCB oil from light ballasts would not be sufficient for minimizing exposures to PCB released from other sources, such as interior caulk. This point is mentioned because Question 6b is not specific about the source of PCBs to which the wipe sampling is directed. The question as phrased is silent on the sources of interest. Thus, if the question pertains to PCB exposures regardless of source, then wipe sampling alone is not likely to be adequate for minimizing exposure of students and staff to PCBs. In that case, air sampling in addition to wipe sampling would be a more comprehensive approach.

6c. If sampling for PCBs in air, is it possible to achieve a low enough detection limit (at least 50 ng/m^3) using a passive sampler?

Reviewer	Comments
Reviewer 1	I have not specifically used passive samples for PCB assessment in indoor air. In my experience with other compounds, the detection limit is based on the specific media and the time the sampler is deployed in the sampling room/media (the longer the time deployed the lower the detection limits).
Reviewer 2	Passive samplers that use polyurethane foam (i.e., PUF-PAS) are used indoors where high volume samplers are impractical; however, its ease of use is also coupled with uncertainty in calculating air concentrations from accumulated mass.[(3)] I am uncertain whether a PUF-PAS can consistently achieve a detection limit of $\leq$ 50 ng/m^3. Further, since the PUF-PAS is not an EPA or NIOSH validated sampling and analytical method for PCBs, I recommend using a traditional method (that is validated) and can consistently achieve a detection limit of 50 ng/m^3. These methods include EPA Method TO-10A (i.e., low volume PUF sampling, 1 to 5 liters per minute), and modified NIOSH Method 5503 (i.e., glass fiber filter and Florisil tube, 1 liter per minute).[(4)] At low PCB concentrations, the NIOSH method was found to be efficient when operated at a flow rates up to 1 L/min; under these conditions, the limit volume adjusted limit of detection was 20 ng/m^3.
Reviewer 3	Passive sampling techniques for PCBs (and other semi-volatiles) are described in the literature. The advantages and disadvantages of passive sampling in comparison to active sampling should be explored before deciding to adopt a passive sampling approach. Other criteria to consider include labor time and cost, laboratory costs, validity, representativeness, accuracy, and precision.

[3] Persoon, C. and K. Hornbuckle. Calculation of Passive Sampling Rates from both Native PCBs and Depuration Compounds in Indoor and Outdoor Environments. Chemosphere 74(7):917-923 (2009).

[4] Kominsky, JR. J. Applied Ind. Hyg. 1(4), R-6 (1986).

6d. The approaches evaluated thus far include patch and repair, removal and encapsulation. Are there other approaches that may be evaluated?

Reviewer	Comments
Reviewer 1	As indicated above, the use of secondary barriers or substrate treatment measures as a component to each of the three remedial options indicated above should be evaluated.
Reviewer 2	Source modification (i.e., reduce the mass of PCBs in the source material such as caulk) individually or in combination with contact encapsulation should be considered. Chemical treatments of PCB-containing building materials include chemical degradation or extraction methods intended to reduce the PCB concentration of the source materials. Commercially available chemical degradation products are typically applied to sources as a slurry or paste, covered with an overlying material and left in place for days to weeks for the chemical reaction to occur. One dechlorination product has been reported to reduce PCB concentrations on various surfaces (such as railroad ballasts, soils and bulk oils) by 90 to 99%.[(5)] Its effectiveness on caulks and painted surfaces is being studied; the status of findings is not known. Another chemical degradation method, known as the Activated Metal Treatment System (AMTS), was developed by NASA.[(5)] The AMTS method eliminates PCBs by dechlorination and has been effective in removing PCBs from paint up to several thousand parts per million. Although the AMTS method was originally designed for painted surfaces, NASA reportedly also developed an improved method applicable to other sources such as caulks. Consider conducting studies to determine its effectiveness to remove PCBs from caulk in the school buildings. Typically, source modification methods are employed as a precursor step to source contact encapsulation or as a follow-up step to bulk removal. Hence, a hybrid approach (i.e., source modification combined with contact encapsulation) should be considered and evaluated as an alternative methodology to source removal. In addition, the applicability and effectiveness of the hybrid methodology may vary with physical condition of the caulk. Caulk found on building exteriors is generally hard and brittle, whereas caulk found on interiors is often soft and flexible. Further, the concentrations of PCBs in the caulk may also vary from exterior to interior caulk.
Reviewer 3	See preceding responses with respect to the use of polyethylene tape as part of an encapsulation remedy. In addition, NYC should consider covering interior PCB-containing caulk with physical barriers such as gypsum board and aluminum strips rather than simply encapsulation. These methods have been demonstrated to be effective elsewhere.

5 U.S. EPA. Literature Review of Remediation Methods for PCBs in Buildings. EPA/600/R-12/-34, January 2012.

6e. Should the caulk management plan address both deteriorated and intact caulk, or should it focus on only one condition of caulk?

Reviewer	Comments
Reviewer 1	As described above, the BMPs have a process for addressing deteriorated caulking under the assumption that it is a PCB caulk. I have no comments or changes to this approach. However, with regard to intact caulking, the parties may want to consider a prioritization to address this caulk based on the potential for exposure, with the two main pathways being dermal contact and inhalation. Under both scenarios, the higher the PCB concentration, the greater the potential risk exposure; therefore, the parties may want to consider a screening approach to identify caulking that may contain higher concentrations of PCBs (given that 82% of the interior caulking samples reported in the pilot study detected PCBs < 50 ppm). I have successfully used chlorine (via an XRF detector) to screen caulking within a building and identify certain caulking samples that could have a greater probability of containing PCBs based on the chlorine concentration. With regard to dermal exposure probability, the higher screened caulking could then be screened based on accessibility to identify materials for some form of remedy or further assessment. For example, interior caulking between a metal door frame and CMU block is typically a narrow bead that is coated/encapsulated with a paint; this caulking would have a lower probability of direct contact given these conditions; and therefore may not need to be a focal point for a remedial action. Whereas, an uncoated caulking along a window sill used for classroom storage or other use may warrant some form of remedy or further assessment. With regard to inhalation, the higher the PCB concentration, the greater the potential for PCB emissions at higher concentrations; therefore, the higher probability caulking could be targeted for a remedy, further assessment, and/or for ventilation assessments and improvements if deemed needed to increase air exchanges (based on a review completed as part of the BMPs).
Reviewer 2	Operations and maintenance (O&M) plans for PCBs in the school buildings should be a major component of the overall management plan to minimize exposure to PCBs by occupants of the school buildings. The O&M plan should include deteriorated and intact caulk with an emphasis on “deteriorated” caulk or caulk that is likely to be disturbed (either intentionally by planned construction activities or unintentionally by building occupants such as students). It is assumed that an inspection has been conducted in each of the school buildings to identify the location of the PCB-containing caulk by either chemical analysis or inference from homogeneous groups of materials. O&M plans should address both primary and secondary source materials and concentrations, locations, conditions, accessibility, abatement and mitigation controls in place, inspections, work practices and controls for contacting and cleaning PCB source materials and the need for additional remediation actions. The O&M plan should also include provisions for periodic air and surface sampling to assess PCB concentrations and effectiveness of mitigation controls.

Reviewer 3	The caulk management plan should focus on all forms of caulk that contain PCBs at percent level concentrations. A focus on deteriorated caulk only would not fully account for vapor phase emissions of PCBs from intact caulk, a very important emission pathway.

6f. The school buildings have been constructed over a period of more than a hundred years and many have been modified during the course of their operation. Air exchange rates under current operating conditions are unknown. Are there procedures, in addition to those specified in the collective bargaining agreement, which would minimize the impact of PCB releases?

Reviewer	Comments
Reviewer 1	The Pilot Study establishes a linear relationship that exists between indoor air PCB concentrations and room air exchanges (i.e., PCB levels tend to decrease as room air exchanges increase). Ventilation systems in the pilot school systems were found not to be operating at their design parameters and when adjusted/ repaired, PCB levels decreased. Given this relationship, more information should be provided in the BMPs in order to determine the effectiveness of this BMP. Specifically, how the ventilation systems will be tested, what specific data will be collected under different operating conditions (exhaust rates, air exchange rates, with windows opened or closed, etc.), and the frequency of testing to know/document if the systems are "operating per design" or at an appropriate level with regard to air exchanges per hour. This ventilation assessment could also be prioritized based on the probability of indoor air releases of PCBs, which could be determined during the screening approach described above (higher probability for rooms with former PCB light ballast fixtures or higher chlorine non-coated caulking).
Reviewer 2	Ventilation with outdoor air is a means of controlling concentrations of PCBs in indoor air from volatilization and/or PCB-bearing particulate independent of source removal or source modification.(5) The pilot study conducted in the three New York City school buildings [NYC DOE, 2010] showed ventilation to be effective for modifying indoor air concentrations and lowering exposures to building-related PCBs. The procedures specified in Appendix F of the Collective Bargaining Agreement for Custodial Engineers relate to cleaning of equipment and not necessarily to performance of the HVAC equipment. The ventilation systems in each school building should be checked to ensure that it is functioning as designed or to applicable sections of ASHRAE Standard 62.1 such the minimum outdoor air rate (cubic feet per minute) per occupant or air exchange rates). Based on the evaluations make appropriate repairs to increase or improve the ventilation as necessary. Improvements or upgrades to existing ventilation system can be effective; however, the cost of heating and cooling outdoor air can be a practical constraint on implementation of this mitigation method.
Reviewer 3	See preceding comments with respect to ventilation.

6g. The proposal is to remove, replace and/or encapsulate caulk if disturbed during the course of routine construction projects. Would proactively addressing the presence of PCBs citywide, regardless of future construction, significantly reduce exposures? If so, what factors are recommended for consideration in identifying buildings that should be prioritized for caulk management activities (e.g., schools with passive ventilation systems, schools with children under 6)?

Reviewer	Comments
Reviewer 1	As discussed at the end of my responses, I believe a stabilization approach where potential exposures are controlled through assessment or interim measures/best management practices until a time when PCB caulk removals can take place is a reasonable approach to addressing this issue. The data presented in the study, as well as other projects I am familiar with, does not prove the "cause-effect" relationship, where the removal of caulking directly results in reduced inhalation exposure potential given potential other sources of PCBs in the indoor environment. There can be a prioritization to this process based on the type of school (focus on K through 8th grade followed by high schools), PCB concentration probability factor, and ventilation assessment (see end of the response document).
Reviewer 2	Proactively addressing the presence of PCBs in school buildings citywide through abatement (source removal and/or source modification), engineering controls (encapsulation, and/or ventilation, and/or air cleaning), and administrative controls (O&M Plan) will significantly lower exposures to PCBs. Intuitively school buildings with passive ventilation (i.e., rely on natural airflow through windows or other openings due to temperature and pressure differences) would be prioritized high for caulk management as well as PCB-containing fluorescent light ballast replacement. To the extent that the available data (air, surface, soil, bulk material, etc.) permits, it is recommended that the data be analyzed to if there is any statistical relationship between air concentration and primary sources (caulk condition, frequency of ballast burnout), secondary sources (concentration in and/or painted surfaces), type of ventilation (mechanical and/or passive), and other factors. If such an analysis is not feasible, consider prioritizing the school buildings based on various factors. These factors include type of ventilation (passive ventilation = highest priority); estimated number of PCB-containing ballast and frequency of ballast burnout; estimated linear feet of PCB-containing caulk interior and exterior; PCB concentration in the caulk (emission rates are proportional to PCB concentration in caulk); and condition of caulk (higher priority caulk is that which is weathered, brittle, or deteriorating). *Points of clarification:* The intent of this recommendation is to identify any relationships between the primary route of exposure (i.e., inhalation of PCB-bearing particulate/vapor) and the principal factors that contribute (e.g., fluorescent lamp ballast burnout) to elevated air concentrations and decreased (e.g., mechanical and/or passive ventilation) air concentrations. That is, which factors have the greatest impact on increasing or decreasing the airborne concentrations of PCBs. This information would then be used to prioritize remedial measures with the intent of reducing inhalation exposures to PCBs. This recommendation is prompted because my review of the document did not show a

	clear basis for prioritizing the options of remedial measures. The conceptual approach would be to identify (based on best engineering judgment) the factors, materials, and/or conditions that appear to have the greatest impact on the airborne concentrations of PCBs in the schools. Realizing of course; the factors, materials and/or conditions may vary with particular architectural characteristics and mechanical systems of the buildings, which may prompt grouping the buildings into homogeneous groups based on the similarity of these characteristics and systems. Once this is done the corresponding empirical data and measurement data (e.g., air concentrations) would then be reviewed to determine the most appropriate statistical approach, either using parametric or non-parametric statistical tests. I am sorry that I cannot more specific, but I am not sufficiently familiar with the empirical and measurement data to offer a more specific blueprint for the needed analysis to best prioritize the remedial approach.
Reviewer 3	Proactively addressing the presence of PCBs city-wide, regardless of future construction has the potential to significantly reduce exposures, especially in schools with interior caulk that contains PCBs at percent concentrations and/or buildings with sub-standard ventilation conditions. The City could consider factors such as type of construction, amount of interior caulk, type of ventilation system, and information on energy intensity for heating and cooling to prioritize caulk management activities.

6h. Would air sampling be an effective means of confirming a recommended prioritization scheme?

Reviewer	Comments
Reviewer 1	As indicated at the end of my responses, indoor air sampling could be a component of the stabilization/prioritization process.
Reviewer 2	Yes, air sampling would be an effective means of confirming a recommended prioritization scheme. While building inspection data identifies the primary (e.g., caulking) and secondary (desorption from paint) sources of PCBs in the school buildings, the ultimate relative exposure risk in the school buildings is based on air concentrations; i.e., EPA's Public Health Guidance Values for PCBs in School Indoor Air. Air sampling data would integrate and quantitate the impact of the source materials to release PCBs through volatilization and as well as PCB-borne particulate due to deterioration and/or disturbance of a material. The effectiveness of air sampling to confirm the prioritization scheme is founded upon the design and implementation of the sampling strategy.
Reviewer 3	Yes, but only if done according to state-of-the-art methods for analysis and interpretation of the data, as well as ensuring that the sampling is representative, and used to support decisions that reflect site-specific performance benchmarks.

6i. The proposal is to evaluate soil for the presence of PCB following construction projects that might disturb exterior caulk. Would proactively evaluating the presence of PCBs in the soil at all schools with exterior PCB caulk, regardless of future construction, significantly reduce exposures?

Reviewer	Comments
Reviewer 1	The data, along with numerous other projects I have been involved in, suggests that if PCB caulk is present on the exterior of a building, then impacts to adjacent soils are likely. The determination of current risks and potential exposures is related to the current condition of the exposed soils adjacent to the subject building (e.g., is this area landscaped and routinely refreshed with mulch or other materials on the surface; is the area routinely accessed by students, such as playground, sandbox, etc.). At a minimum, a survey as to the accessibility/use of exposed soil adjacent to each of the schools (within 10 feet of the building) with exterior PCB caulk should be considered and made part of the stabilized conditions review (see below). Based on the survey, recommendations for best practices could be made/implemented until the soil is addressed during a renovation/construction project. These best practices could include: soil coverings via fabric/mulch or some other landscaping materials; change in use or move activity that disturbs these soils to a different location; etc.).
Reviewer 2	Analysis by EPA of the soil samples collected from the five pilot schools P.S. 178 and 176 indicate the greater concentrations of PCBs were found at depth (5 to 10 cm) than were found in surface soil samples (0 to 5 cm) at locations <10 ft from the school building exterior. EPA concluded that the contamination resulted from disturbance of the in place caulking during historical construction activities and not due to release of caulking that flake off due to weathering. If this data is representative of the other school buildings it indicates that potential exposure from soil contamination may not be significant due to reduced accessibility to the contamination by soil cover. Further sampling should be conducted to verify this possibility. The releasability of PCBs from the soil could be determined *in situ* using a RAFS technology[(6)] and the corresponding exposure concentration could be determined using a breathing zone model[(7)] developed with the RAFS technology. This technology was developed and validated under research contracts with EPA's Office of Research and Development (ORD), National Risk Management Research Laboratory in Cincinnati. The resultant RAFS data could be used to make risk-based decisions on the necessity for soil remediation at the exterior of the school buildings.
Reviewer 3	Unlikely. Rates of exposure to PCBs associated with building-related PCB levels in soil are typically very low in comparison to PCBs exposures that arise from anthropogenic background PCBs levels in environmental media and in indoor air of buildings with interior sources of PCB emissions. As such, proactive evaluation of PCBs in soil would

[6] Kominsky, J.R., J.W. Thornburg, G. Shaul, et al. *Development and Design of Releasable Asbestos Field Sampler*. J. Air & Waste Management Assoc. 60:294-301 (2010).

[7] Thornburg, J.W., J.R. Kominsky, G.G. Brown et al. A Model to Predict the Breathing Zone Concentrations of Particles Emitted from Surfaces. J. Environ. Monit. 12:973-980 (2010).

	likely yield a negligible exposure benefit in the opinion of this reviewer.

6j. Are there any perceived data gaps or limitations not identified by NYC?

Reviewer	Comments
Reviewer 1	The Report, EPA studies, and other private and/or public renovation projects at schools completed in other areas of the country make it clear that there could be numerous PCB-containing materials with a school building. However, mere presence of a PCB-containing material does not directly correlate to potential exposures to students and/or occupants. A number of factors can contribute to conditions that could result in potential exposures to PCBs. As such, a multiple building programmatic remedial approach may want to consider focusing on a stabilization approach through assessment, interim measures, or best management practices (i.e., establishing human health potential exposures under control) until a final remedy (most likely to be source removal and off-site disposal) can be implemented at each school. A suggested series of questions and responses to guide the assessment and prioritization is provided below for discussion. **Stabilization/Prioritization Approach Suggestion** <u>Are Interim Measures /Best Management Practices Needed?</u> 1. For buildings constructed between 1950 and 1978, are higher probable potential PCB primary sources for school settings present? a. Yes, if caulking and glazing sealants are present b. Yes, if T-12 light ballasts are present 2. If caulking or glazing sealants are present, is the caulking or sealant in a flaking, cracking, or otherwise exhibiting visual signs of significant deterioration? a. If yes, then implement BMP for corrective action assuming material is a ≥ 50 ppm PCB-containing material (patch/repair, remove/dispose, or encapsulation, incorporating a secondary barrier component, as warranted) 3. If no to Question 2, is the intact, good condition caulking or glazing sealants reasonably likely to contain higher concentrations of PCBs (i.e., ≥ 50 ppm) based on chlorine screening? (higher concentrations of PCBs increase the probability of emissions or other transport pathway/exposures) a. If yes, is caulking or sealant currently in a highly accessible location and uncoated? i. If yes, then implement BMP for encapsulation, incorporating a secondary barrier component, as warranted; ii. If no (i.e., currently coated or inaccessible), no action at this time b. If no to Question 3 (i.e., lower probability of elevated PCB containing materials), then no action at this time

	4. If T-12 light ballasts are present, remove in accordance with City's light ballast inspection and removal program (all T-12 light ballasts to be removed by December 31, 2016; schools with leaking ballasts (of which all have been removed per the November 27, 2013 web-site posting) will be prioritized for full fixture replacements a. If T-12 light ballast found to be leaking outside of the fixture, implement the removal and re-occupancy protocol <u>Are additional assessments or actions required in Interim Measure Areas (e.g., areas with T-12 light ballasts and/or caulking in a deteriorated condition or intact caulking in accessible areas with high chlorine screening results)?</u> 1. Is interior high or low contact surfaces known or reasonably suspected to be impacted over appropriately protective risk-based levels? (assumes complete direct contact pathway is present for indoor environments and all suspected PCB caulk has been encapsulated or removed as in Interim Measure/ Best Management Practice - see above) a. Based on the implementation of the cleaning BMPs and surface wipe data collected in the pilot study schools, it is not suspected that high or low contact surfaces would be impacted over appropriately protective risk based levels provided the cleaning best practices are continued; therefore, no further actions with regard to potential direct contact exposures on surfaces. 2. Is indoor air known or reasonably suspected to be impacted over appropriately protective risk-based levels? (assumes complete inhalation pathway is present for indoor environments; all suspected PCB caulk has been encapsulated or removed as in Interim Measure/ Best Management Practice - see above; and all leaking ballasts have been removed/replaced with all T-12 ballasts to be removed by December 31, 2016) a. Document ventilation system operating parameters and appropriate number of room air exchanges, as described in the BMPs i. If BMP criteria are met, no further action (given primary sources removed or encapsulated) ii. If BMP criteria are not met, implement corrective measures to return system to proper operation b. Assess need to test indoor air on a case by case basis given ventilation system operation results i. If testing determined to be warranted, develop sampling plan to assess indoor air levels over time and determine acceptable limits/action levels 1. If indoor air results are within acceptable limits, no further action 2. If indoor air results are not within acceptable limits, implement additional corrective measures, including increasing room air exchanges, potential air treatment, secondary or primary source removals or decontamination, etc. depending on room specific conditions

	3. Is adjacent exterior soil known or reasonably suspected to be impacted over appropriately protective risk-based levels and a complete pathway is present? a. Are soils within 10 feet of the building accessible and in use by school students or staff? i. If yes, implement Interim Measure to isolate surface soils though barrier system and/or move/relocate currently uses to another location ii. If no, no further action at this time since no complete pathway b. Assess and remediate soils during renovation/construction project that will involve soil disturbance
Reviewer 2	The existing limitations and data gaps not identified by NYC include: • Consider conducting additional studies to evaluate the efficacy of a hybrid approach of source modification plus contact encapsulation as an alternative methodology to source removal. That is, management in place vs. removal of the caulk unless the material will be directly affected by a construction activity; see item 6d. • Consider collection additional data to make risk-based decisions on the necessity for soil remediation at the exterior of the school buildings; see Item 6i.
Reviewer 3	See responses to the preceding questions. In addition, this reviewer strongly recommends an analysis of the value of information gained from any additional studies. Managing building-related PCBs in schools is an important municipal activity. In practical situations like this one, questions are generally valuable to answer only when the answer(s) has the potential to result in a change of course or action. The value of information from the additional studies mentioned is not demonstrated in the report. This lack of information is a data gap in the opinion of this reviewer. The report should explain why the Preferred Citywide Remedy does not include air sampling in New York City schools constructed during the period when PCB-containing building materials were in commerce. EPA guidance recommends air testing when information on potential exposures is desired. Moreover, the pilot study demonstrates that PCB levels in some schools, at some times, can be well above the public health targets for PCB exposure concentrations in indoor air provided by EPA. The absence of discussion of the contrast between the BMP plan and EPA guidance is a gap in the report. Adding such a discussion has the potential to improve the clarity of the report and to strengthen the conclusions.

Appendix A: Individual Reviewer Comments

Reviewer 1 Comments

External Letter Peer Review of Report on PCB Caulk in New York City School Buildings

Responses to Charge Questions by Reviewer 1

1. Does the Summary Report dated May 24, 2013 clearly and comprehensively describe the sources, environmental levels, and potential exposures for PCBs in school buildings?

The Report presented information on the sources, environmental levels, and potential exposures in such a fashion that I could develop an understanding of each at the respective school buildings.

I understand that this is a summary report and relies on information presented in previous reports, specifically the Remedial Investigation Reports (RIRs); however, the sequential presentation of data was somewhat confusing and I needed to review both RIRs in detail prior to understanding the Summary Report presentation. References to data tables in multiple reports and appendices was also not easy to follow as compared to an overall summary table of data by school, room, and date (including remedial action) for each environmental media, which would have been helpful.

In addition, the author's may want to consider presenting the data and results by school instead of by activity because in the end many different remedies/activities were conducted at each school in addition to the primary remedy under evaluation. It was difficult to draw an overall conclusion on the effectiveness of the specific remedy because many different activities were conducted in response to lowering the indoor air levels. If there were specific rooms where only a patch/repair or encapsulation was conducted and no light ballasts removals or cleaning or ventilation changes completed, then a specific evaluation of that remedy/activity could be performed in the context of the remedy objectives (as a standalone remedy); if this condition was evaluated is was not clearly explained in the report for each school. For example, at one school (P.S. 3R), the report discussed the results of indoor air concentration reduction in a stairwell that was attributable to a PCB caulk repair and encapsulation event (page 43 of the Final RIR); this finding is specific to removal action and was helpful in determining the potential effectiveness of the remedial option.

2. Please comment on the appropriateness of the remedies selected. Do they provide adequate reductions of the exposure to PCBs? If not, do you have suggestions for additional reductions that could be achieved, given the available data?

I think the remedies that evaluated options for the caulking were appropriate (removal or encapsulation) with the exception that a decontamination or treatment remedial component could have been included. My experience with these decontamination/treatment options is that they could have been integrated as a component into one of the remedial options evaluated and not as a standalone remedial option. For example, following caulk removal, the substrate could have been treated prior to applying the new caulking. The goal of the treatment step would be to reduce PCB concentrations in the substrate to limit the amount of PCBs available to migrate into the new caulking. It is acknowledged that existing PCB decontamination products are difficult to apply on vertical building surfaces or in narrow spaces, where caulking is typically applied, so the practicality of this step may only be available during larger scale renovation or capital improvement projects.

In my experience at multiple buildings, the phenomenon of recontamination of replacement caulking with PCBs is common and predicates the need for a secondary barrier to either:

1. isolate the PCBs into the substrate and limit/eliminate migrate into the replacement caulk;
    a. this can be reasonably accomplished by using a liquid epoxy on the substrate, allowing the product to cure, collecting wipe samples to verify PCBs have been encapsulated, and then applying the replacement caulk
2. isolate the PCBs from the encapsulating coating.
    a. this can be accomplished by using a liquid coating (e.g., an epoxy) applied over the PCB-containing material as an initial encapsulant followed by the final coating for the surface, or by applying a non-liquid barrier (e.g., a metallic tape or similar material) over the PCB-containing caulking following by new caulking.

A typical sequence of remedial steps under a removal scenario that we have implemented at numerous building consists of:

- Removal PCB caulk and residuals;
- Optional step: decontaminate or treat substrate to reduce levels of PCBs in the substrate (limitations on product selection and timing of application in context of overall project work [e.g., a window replacement project]);
- Apply secondary barrier, typically a quick-cure liquid epoxy, to the substrate to “seal” PCBs into the substrate
- Apply new bead of replacement caulk

The BMPs appear to provide an appropriate level of inspections and corrective measures for deteriorating caulk and cleaning of surfaces. The Report makes it clear that the cleaning practices typically implemented by the school staff result in limited PCBs on high or low contact surfaces and should be continued as stated in the Report.

The BMPs do not address PCB caulk in good condition, although is not certain that PCB caulk in an intact non-deteriorating condition needs to be addressed in the near-term (see additional discussion/comments provided to other questions below). The focus on maintaining the HVAC and ventilation systems is appropriate and needed; however, refer to comments below on the effectiveness of the procedures with regard to achieving the goal of proper ventilation.

3. For each remedy: Does the remedy provide sufficient information to reasonably demonstrate the effectiveness of the proposed remedy? If not, what additional information is needed?

Patch and Repair of PCB Caulk, Remove and Replace PCB Caulk, and Caulk Removal associated with Window Removal -

These three remedies all involve the removal and replacement of PCB caulk. Given the PCB caulk is removed, the remedy is effective in eliminating the exposure and contamination from the PCB caulk, except in areas where only deteriorated caulk is removed (incomplete removal). The report indicates that these removal remedies are not effective given the re-contamination of the replacement caulk with PCBs from the underlying substrate. As indicated above, this condition could be addressed through the application of a secondary barrier (as it has been effectively completed at many sites within Region 1). As evaluated, the remedy conclusions appear correct; however, the removal remedy should not be removed from further evaluation given that an added step (secondary barrier) could be implemented to render the removal remedies effective in meeting the project objectives.

Encapsulation of PCB Caulk -

The effectiveness and conclusions drawn from the Encapsulation Remedy were based on surface wipe samples collected using hexane-soaked wipes following standard surface wipe sampling procedures. However, the use of hexane, or any other aggressive organic solvent, on a porous media (paint/coating) over another porous media (PCB caulk) may not represent actual surface concentrations on the subject coating. Given the aggressiveness of the solvent and the porosity and organic nature of the coating, the solvent could be "pulling/extracting" PCBs from the PCB caulk and through the coating. In addition, hexane may also deteriorate or breakdown the coating itself. If this phenomenon is occurring, then the wipe samples may not be assessing PCB concentrations on the surface of the encapsulant and those available for dermal contact.

If the intent of the encapsulation remedy is to coat/isolate the underlying PCB caulk in order to prevent dermal contact and dust generation, then the parties may want to consider a performance measurement method that emulates dermal/direct contact, such as a wipe soaked in saline (to emulate skin conditions), a dry wipe, or a wipe soaked in some other media/non-organic solvent.

By applying an intact coating over the caulking, the objective of eliminating future dust generation appears to have been met, but this is not mentioned in the Report. One would think that the coating would also reduce the amount of PCBs subject to direct contact/dermal exposure given its presence; however, pre-application wipe tests are not provided to compare to the post-application wipe tests to evaluate this effect.

Removal and Replacement of Light Fixtures with PCB Ballasts -

Given that PCB containing light fixtures will be removed, this remedy is considered effective in meeting the project objectives. It has also been shown that this remedy will also have an effect on reducing PCB concentrations in indoor air, if present.

<u>Best Management Practices</u> -

The BMPs appear to provide an effective means for inspections and corrective measures for deteriorating caulk and cleaning of surfaces. The Report makes it clear that the cleaning practices typically implemented by the school staff result in limited PCBs on high or low contact surfaces and should be continued as stated in the Report.

The BMPs do not address PCB caulk in good condition, although is not certain that PCB caulk in an intact non-deteriorating condition needs to be addressed in the near-term (see additional discussion/comments provided to other questions below).

The Report establishes a linear relationship that exists between indoor air PCB concentrations and room air exchanges (i.e., PCB levels tend to decrease as room air exchanges increase). Ventilation systems in the pilot schools systems were found not to be operating at their design parameters and when adjusted/repaired, PCB levels in indoor air decreased. Given this relationship, more information should be provided in the BMPs in order to determine the effectiveness of this BMP. Specifically, how the ventilation systems will be tested, which data will be collected under different operating conditions (exhaust rates, air exchange rates, with windows opened or closed, etc.), and the frequency of testing to know/document if the systems are "operating per design" or at an appropriate level with regard to air exchanges per hour.

4. **For each remedy: Are the methodologies used consistent with the state-of-science? If not, please provide specific references and suggestions for revision.**

With regard to the removal remedies and as described above in more detail, the use of a secondary barrier and treatment or decontamination methods for concentration reductions of the substrate should have been considered/implemented to fully evaluate these remedies.

With regard to the encapsulation remedy, the use of other verification testing techniques (wipe extractants) should have been considered to fully evaluate the remedy.

Overall, the post remediation indoor air samples were typically collected within a month or so of the remedy implementation. I understand the limitations of working over the summer months when school is not in session; however, this short timeframe may not have been enough time to address the effectiveness of the remedies (given the context of seasonal variabilities and other operating conditions). The reports do not comment on the amount of air exchanges or ventilation rates in the remediated areas prior to collecting the post remediation indoor air samples. Additional samples were collected in several schools at later times; however, these were in response to additional activities (cleaning, ventilation increases, etc.) in order to reduce the indoor air levels. As such, a specific "cause-effect" condition with regard to the specific remedial action implemented and its effect on indoor air concentrations over time is difficult to determine with the data collected/presented.

I thought the Relative Source Strength (RSS) approach was a sound approach to focus the investigation and potential corrective measures within a room or school building. It would be interesting if the RSS was also calculated for the primary sources to assess their potential contribution.

5. Do you have specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report?

The Report indicates that the Preferred Citywide Remedy will be integrated into a Citywide PCB Management Plan that will be phased in a prioritization approach. This makes sense given the number of subject schools; however, the Preferred Citywide Remedy should also have some prioritization components, as well, to focus the remedy within each of the schools. A couple of examples are provided below.

The data presented indicates that 82% of the interior caulking samples reported PCBs < 50 ppm. I have seen this condition (interior caulking with lower levels of PCBs compared to exterior caulking) at many other buildings as well. This condition should be reviewed in the context of the assumption that all caulking at the subject buildings is a PCB caulk (i.e., ≥ 50 ppm total PCBs). An overall objective of this work should be to ensure that students and occupants of the building are protective from adverse exposures to PCBs. The BMPs have a process for addressing deteriorated caulking under the assumption that it is a PCB caulk. I have no comments or changes to this approach. However, with regard to intact caulking, the parties may want to consider a prioritization to address this caulk based on the potential for exposure, with the two main pathways being dermal contact and inhalation.

Under both scenarios, the higher the PCB concentration, the greater the potential risk exposure; therefore, the parties may want to consider a screening approach to identify caulking that may contain higher concentrations of PCBs. I have successfully used chlorine (via an XRF detector) to screen caulking within a building and identify certain caulking samples that could have a greater probability of containing PCBs based on the chlorine concentration.

With regard to dermal exposure probability, the higher screened caulking could then be screened based on accessibility to identify materials for some form of remedy or further assessment. For example, interior caulking between a metal door frame and CMU block is typically a narrow bead that is coated/encapsulated with a paint; this caulking would have a lower probability of direct contact given these conditions; and therefore may not need to be a focal point for a remedial action. Whereas, an uncoated caulking along a window sill used for classroom storage or other use may warrant some form of remedy or further assessment.

With regard to inhalation, the higher the PCB concentration, the greater the potential for PCB emissions at higher concentrations; therefore, the higher probability caulking could be targeted for a remedy, further assessment, and/or for ventilation assessments and improvements if deemed needed to increase air exchanges (based on a review completed as part of the BMPs).

6. Below (in blue font) are elements of the proposed Preferred Citywide Remedy taken from the Executive Summary. Charge questions 6a through 6j are specific to those portions of the remedy.

- **PCB Ballast and Associated Light Fixture Management and Replacement -** The City will continue to implement its ongoing program whereby all light fixtures that use or used PCB ballasts and associated light fixtures in New York City public school buildings are removed and replaced on a prioritized basis. All light fixture replacements projects will be completed by December 31, 2016. *(No specific questions related to this portion. The timeframe is the result of a court settlement.)*

- **Interim Visual Inspection and PCB Response Action Program:** The City will also continue its program whereby T12 lighting fixtures (which may contain PCB ballasts) are inspected on a regular basis by custodial staff for evidence of brownish black residue on any of the following: light diffuser (lens), light housing, or any area directly below lighting fixtures (furniture or floor). If leaks are observed, the fixture and the intact ballast or the ballast alone (if only the ballast has PCBs and there are no stains on the fixture) is removed by an electrician. Finally, procedures are in place and will continue to be implemented for the limited cases when PCB ballast leakage occurs outside the fixture (housing or diffuser) or when smoke is emitted from ballasts. This procedure includes the expedited removal of the ballasts and/or fixtures, aggressive ventilation, and cleaning or removal and disposal of any additional impacted items, with confirmatory wipe sampling for PCBs. Both protocols are annexed hereto and would be interim components of the preferred remedy.

6a. Are there alternatives to the visual inspection protocol for detecting ballasts that have leaked?

I think that a direct visual inspection is an appropriate method to determine if a liquid leak has occurred. Other ancillary methods (wipe tests, etc.) would be difficult to predict if it was a result of a liquid leak or some other transport pathway. However, to completely ascertain if a liquid leak had occurred, the specific FLB should be inspected by opening the fixture.

6b. EPA has suggested revising the re-occupancy protocol to include post clean up air sampling in addition to the current practice of surface wipe sampling for PCBs. Is wipe sampling alone adequate to minimize exposure of students and staff to PCBs?

In response to your question, the answer would be no, wipe sampling alone is not sufficient to assess potential exposure from PCBs to occupants in a room. However, as the Pilot Tests indicated, there are multiple potential sources of PCBs to indoor air, in addition to PCB light ballasts. As the data showed, the removal of PCB light ballasts had the greatest effect on lowering indoor air concentrations. The next mitigation method was ensuring the room's ventilation system was operating properly and potentially increasing air exchange rates to flush residual indoor air.

Given the potential for other contributing sources, I do not think that an indoor air test should be made part of the re-occupancy protocol as it relates to the re-occupancy of the subject room. Although, the room should be prioritized for a ventilation system assessment and screening (as described below) to assess potential inhalation concerns and stabilization measures, which may include indoor air monitoring.

6c. If sampling for PCBs in air, is it possible to achieve a low enough detection limit (at least 50 ng/m^3) using a passive sampler?

I have not specifically used passive samples for PCB assessment in indoor air. In my experience with other compounds, the detection limit is based on the specific media and the time the sampler is deployed in the sampling room/media (the longer the time deployed the lower the detection limits).

- **Continued Assessment with EPA on Potential Caulk Remedial Measures:** While the measures thus far evaluated in the Pilot Study have yet to yield an effective remedy for PCB caulk, the work performed during the pilot study has yielded invaluable data and information on potential remedial measures designed to address this complex issue. As part of the preferred remedy, the City would like to continue this work under EPA's oversight by performing evaluations of new remedial approaches for PCB caulk. The City would perform this work in schools where fixtures containing PCB light ballasts have already been removed.

6d. The approaches evaluated thus far include patch and repair, removal and encapsulation. Are there other approaches that may be evaluated?

As indicated above, the use of secondary barriers or substrate treatment measures as a component to each of the three remedial options indicated above should be evaluated.

- **Best Management Practices -** The Best Management Practices (BMP), as approved by EPA in April 2012, will be implemented. This includes employing strategies for managing PCB caulk and ensuring safe and proper operation of all heating, air conditioning, ventilating and similar equipment (collectively "HVAC").
  - **PCB Caulk Management-** Measures and practices will be used to protect interior and exterior PCB caulk from accidental damage and to identify the potential for deterioration through routine inspections requiring further action on an ongoing basis during school maintenance, repair and renovation. The BMPs also reference remediation of deteriorated PCB caulk by removal and replacement, patch and repair, or encapsulation.

6e. Should the caulk management plan address both deteriorated and intact caulk, or should it focus on only one condition of caulk?

As described above, the BMPs have a process for addressing deteriorated caulking under the assumption that it is a PCB caulk. I have no comments or changes to this approach. However, with regard to intact caulking, the parties may want to consider a prioritization to address this caulk based on the potential for exposure, with the two main pathways being dermal contact and inhalation.

Under both scenarios, the higher the PCB concentration, the greater the potential risk exposure; therefore, the parties may want to consider a screening approach to identify caulking that may contain higher concentrations of PCBs (given that 82% of the interior caulking samples reported in the pilot study detected PCBs < 50 ppm). I have successfully used chlorine (via an XRF detector) to screen caulking within a building and identify certain caulking samples that could have a greater probability of containing PCBs based on the chlorine concentration.

With regard to dermal exposure probability, the higher screened caulking could then be screened based on accessibility to identify materials for some form of remedy or further assessment. For example, interior caulking between a metal door frame and CMU block is typically a narrow bead that is coated/encapsulated with a paint; this caulking would have a lower probability of direct contact given these conditions; and therefore may not need to be a focal point for a remedial action. Whereas, an uncoated caulking along a window sill used for classroom storage or other use may warrant some form of remedy or further assessment.

With regard to inhalation, the higher the PCB concentration, the greater the potential for PCB emissions at higher concentrations; therefore, the higher probability caulking could be targeted for a remedy, further assessment, and/or for ventilation assessments and improvements if deemed needed to increase air exchanges (based on a review completed as part of the BMPs).

- **Heating Ventilating and Air Conditioning Maintenance** Building Air exchange rates will be maintained per design by ensuring that the HVAC and general ventilation systems are operating properly in accordance with the requirements contained in Appendix F of the Collective Bargaining Agreement. HVAC and general ventilation supply and exhaust fans will be operated while schools are occupied. Heating stacks, where designed primarily for ventilation rather than heating, shall be used to provide tempered fresh air while buildings are occupied. The City will maintain, adjust and make minor repairs to systems as needed. If there are problems identified with the systems that are beyond the ability of the appropriate building staff to directly rectify, a work request will be submitted on an expedited priority of a time sensitive nature.

6f. The school buildings have been constructed over a period of more than a hundred years and many have been modified during the course of their operation. Air exchange rates under current operating conditions are unknown. Are there procedures, in addition to those specified in the collective bargaining agreement, which would minimize the impact of PCB releases?

The Pilot Study establishes a linear relationship that exists between indoor air PCB concentrations and room air exchanges (i.e., PCB levels tend to decrease as room air exchanges increase). Ventilation systems in the pilot school systems were found not to be operating at their design parameters and when adjusted/repaired, PCB levels decreased. Given this relationship, more information should be provided in the BMPs in order to determine the effectiveness of this BMP. Specifically, how the ventilation systems will be tested, what specific data will be collected under different operating conditions (exhaust rates, air exchange rates, with windows opened or closed, etc.), and the frequency of testing to know/document if the systems are “operating per design” or at an appropriate level with regard to air exchanges per hour.

This ventilation assessment could also be prioritized based on the probability of indoor air releases of PCBs, which could be determined during the screening approach described above (higher probability for rooms with former PCB light ballast fixtures or higher chlorine non-coated caulking).

- **Removal, Replacement and Encapsulation of Caulk -** As presented in the BMP, capital projects to renovate schools will be performed by the New York City School Construction Authority (SCA) in accordance with standard construction specifications which have been developed to properly manage and dispose of PCB caulk when it is disturbed during renovation activities. These protocols require rigorous dust control measures during the work followed by cleaning and inspection at the conclusion of every work shift to minimize the potential exposure to PCB-containing dust during construction.

6g. The proposal is to remove, replace and/or encapsulate caulk if disturbed during the course of routine construction projects. Would proactively addressing the presence of PCBs city-wide, regardless of future construction, significantly reduce exposures? If so, what factors are recommended for consideration in identifying buildings that should be prioritized for caulk management activities (e.g., schools with passive ventilation systems, schools with children under 6)?

As discussed at the end of my responses, I believe a stabilization approach where potential exposures are controlled through assessment or interim measures/best management practices until a time when PCB caulk removals can take place is a reasonable approach to addressing this issue. The data presented in the study, as well as other projects I am familiar with, does not prove the "cause-effect" relationship, where the removal of caulking directly results in reduced inhalation exposure potential given potential other sources of PCBs in the indoor environment. There can be a prioritization to this process based on the type of school (focus on K through 8th grade followed by high schools), PCB concentration probability factor, and ventilation assessment (see end of the response document).

6h. Would air sampling be an effective means of confirming a recommended prioritization scheme?

As indicated at the end of my responses, indoor air sampling could be a component of the stabilization/prioritization process.

- **Soil Evaluation, Excavation and Replacement -** SCA will evaluate the presence of PCBs in the surface soil within outside exposure areas (i.e., soil within ten feet of the building face), following the completion of construction projects that disturb exterior PCB caulk. Any surface soil within ten feet of the building found to contain PCBs at a concentration of greater than the 1 ppm guidance value will be the subject of remediation by excavation and off-site disposal. Confirmatory post-excavation soil results will be obtained. After removing contaminated soil, the excavation will be backfilled using clean fill.

6i. The proposal is to evaluate soil for the presence of PCB following construction projects that might disturb exterior caulk. Would proactively evaluating the presence of PCBs in the soil at all schools with exterior PCB caulk, regardless of future construction, significantly reduce exposures?

The data, along with numerous other projects I have been involved in, suggests that if PCB caulk is present on the exterior of a building, then impacts to adjacent soils are likely. The determination of current risks and potential exposures is related to the current condition of the exposed soils adjacent to the subject building (e.g., is this area landscaped and routinely refreshed with mulch or other materials on the surface; is the area routinely accessed by students, such as playground, sandbox, etc.).

At a minimum, a survey as to the accessibility/use of exposed soil adjacent to each of the schools (within 10 feet of the building) with exterior PCB caulk should be considered and made part of the stabilized conditions review (see below). Based on the survey, recommendations for best practices could be made/ implemented until the soil is addressed during a renovation/construction project. These best practices could include: soil coverings via fabric/mulch or some other landscaping materials; change in use or move activity that disturbs these soils to a different location; etc.).

- **Public Outreach -** The City will implement public outreach pursuant to Local Laws 68 and Local Laws 69 of 2011 (see Appendix A). In addition, the City shall continue to maintain its updated website, which provides email updates to those who request such notices. The website will, among other things, provide information on the City's progress to remove PCB light fixtures. (*No specific questions related to this portion. These are terms of the CAFO.)*

- Finally, due to existing limitations and data gaps associated with managing PCBs in school buildings additional studies are recommended in the areas of long-term monitoring, encapsulation of caulk and substrate, and activated carbon air filtration. It is anticipated that the proposed approach to managing PCBs in the schools will be subject to change based on future data collection and data evaluation.

6j. Are there any perceived data gaps or limitations not identified by NYC?

The Report, EPA studies, and other private and/or public renovation projects at schools completed in other areas of the country make it clear that there could be numerous PCB-containing materials with a school building. However, mere presence of a PCB-containing material does not directly correlate to potential exposures to students and/or occupants. A number of factors can contribute to conditions that could result in potential exposures to PCBs.

As such, a multiple building programmatic remedial approach may want to consider focusing on a stabilization approach through assessment, interim measures, or best management practices (i.e., establishing human health potential exposures under control) until a final remedy (most likely to be source removal and off-site disposal) can be implemented at each school.

A suggested series of questions and responses to guide the assessment and prioritization is provided below for discussion.

Stabilization/Prioritization Approach Suggestion

<u>Are Interim Measures /Best Management Practices Needed?</u>

1. For buildings constructed between 1950 and 1978, are higher probable potential PCB primary sources for school settings present?
   a. Yes, if caulking and glazing sealants are present
   b. Yes, if T-12 light ballasts are present
2. If caulking or glazing sealants are present, is the caulking or sealant in a flaking, cracking, or otherwise exhibiting visual signs of significant deterioration?
   a. If yes, then implement BMP for corrective action assuming material is a ≥ 50 ppm PCB-containing material (patch/repair, remove/dispose, or encapsulation, incorporating a secondary barrier component, as warranted)
3. If no to Question 2, is the intact, good condition caulking or glazing sealants reasonably likely to contain higher concentrations of PCBs (i.e., ≥ 50 ppm) based on chlorine screening? (higher concentrations of PCBs increase the probability of emissions or other transport pathway/exposures)

a. If yes, is caulking or sealant currently in a highly accessible location and uncoated?

i. If yes, then implement BMP for encapsulation, incorporating a secondary barrier component, as warranted;

ii. If no (i.e., currently coated or inaccessible), no action at this time

b. If no to Question 3 (i.e., lower probability of elevated PCB containing materials), then no action at this time

4. If T-12 light ballasts are present, remove in accordance with City's light ballast inspection and removal program (all T-12 light ballasts to be removed by December 31, 2016; schools with leaking ballasts (of which all have been removed per the November 27, 2013 web-site posting) will be prioritized for full fixture replacements

a. If T-12 light ballast found to be leaking outside of the fixture, implement the removal and re-occupancy protocol

<u>Are additional assessments or actions required in Interim Measure Areas (e.g., areas with T-12 light ballasts and/or caulking in a deteriorated condition or intact caulking in accessible areas with high chlorine screening results)?</u>

1. Is interior high or low contact surfaces known or reasonably suspected to be impacted over appropriately protective risk-based levels? (assumes complete direct contact pathway is present for indoor environments and all suspected PCB caulk has been encapsulated or removed as in Interim Measure/ Best Management Practice - see above)

a. Based on the implementation of the cleaning BMPs and surface wipe data collected in the pilot study schools, it is not suspected that high or low contact surfaces would be impacted over appropriately protective risk based levels provided the cleaning best practices are continued; therefore, no further actions with regard to potential direct contact exposures on surfaces.

2. Is indoor air known or reasonably suspected to be impacted over appropriately protective risk-based levels? (assumes complete inhalation pathway is present for indoor environments; all suspected PCB caulk has been encapsulated or removed as in Interim Measure/ Best Management Practice - see above; and all leaking ballasts have been removed/replaced with all T-12 ballasts to be removed by December 31, 2016)

a. Document ventilation system operating parameters and appropriate number of room air exchanges, as described in the BMPs

i. If BMP criteria are met, no further action (given primary sources removed or encapsulated)

ii. If BMP criteria are not met, implement corrective measures to return system to proper operation

b. Assess need to test indoor air on a case by case basis given ventilation system operation results

i. If testing determined to be warranted, develop sampling plan to assess indoor air levels over time and determine acceptable limits/action levels

1. If indoor air results are within acceptable limits, no further action

2. If indoor air results are not within acceptable limits, implement additional corrective measures, including increasing room air exchanges, potential air treatment, secondary or primary source removals or decontamination, etc. depending on room specific conditions

3. Is adjacent exterior soil known or reasonably suspected to be impacted over appropriately protective risk-based levels and a complete pathway is present?

   a. Are soils within 10 feet of the building accessible and in use by school students or staff?

      i. If yes, implement Interim Measure to isolate surface soils though barrier system and/or move/relocate currently uses to another location

      ii. If no, no further action at this time since no complete pathway

   b. Assess and remediate soils during renovation/construction project that will involve soil disturbance

Reviewer 2 Comments

External Letter Peer Review of Report on PCB Caulk in New York City School Buildings

Responses to Charge Questions by Reviewer 2

1. **Does the Summary Report dated May 24, 2013 clearly and comprehensively describe the sources, environmental levels, and potential exposures for PCBs in school buildings.**

   The Summary Report does not provide a concise comprehensive description of the sources, environmental levels, and potential exposure for PCBs in school buildings. It attempts to achieve this objective by referencing the EPA PCBs in School Buildings report and extraction of some information/data from thereof. A few summary paragraphs such as those in Section 5.1 of the EPA PCBs in School Buildings report would be very informative. The summary paragraphs would be best suited for inclusion in Section 1.2 "Background" of the May 24 report.

   Although the NYC school buildings were inspected for other primary sources of PCBs (i.e., fluorescent light ballast), it is uncertain whether mastics used to adhere thermal insulation to exterior of ventilation ducts were considered, which could be a significant source of PCBs in buildings. If this is applicable to the school buildings, please consider the information contained in the following paper: Kominsky, JR. *PCB-Containing Adhesive in Ventilation Ducts: A Significant Source of Contamination in an Office Building*, Proceedings U.S. EPA Symposium Engineering Solutions to Indoor Air Quality Problems, July 17-19, 2000.

2. **Please comment on the appropriateness of the remedies selected. Do they provide adequate reductions of the exposure to PCBs? If not, do you have suggestions for additional reductions that could be achieved, given the available data?"**

   Overall, I agree that diligent implementation of the proposed multiple remedial measures to eliminate the primary sources of PCBs (caulking and fluorescent light ballast) will ultimately reduce inhalation exposure by school building occupants to PCBs below the EPA Public Health Guidance Values. Eliminating PCB-containing interior/exterior caulk as a primary source of PCBs in and around the school buildings is more problematic (and effective remedial measures are yet to be finalized) than eliminating the other primary source, PCB-containing fluorescent light ballasts. Although both sources must be resolved to achieve the ultimate goal, resources to eliminate the "low-hanging-fruit" (replacement PCB-containing ballasts) should be more aggressive. Implementation of the PCB-Containing Ballast/Fixture Replacement and Inspection/Response Action Program remedial measure in combination with increasing the volume of outdoor air would likely have an "immediate to near-term" impact on reducing the PCB exposure levels in the school buildings.

   Although the number of PCB-containing fluorescent light ballast present in the 645 school buildings nor the frequency of electrical-thermal failure of the ballasts are known, removal of these ballasts will likely have the greatest impact on the reducing airborne and dermal exposure to PCBs. A diligent interim inspection and ballast-failure response program will definitely reduce exposure to PCBs by school building occupants as well as reduce further PCB air/surface contamination levels in the buildings. A study conducted in the Seattle School District (1987)[1,2] showed levels of airborne PCBs that ranged from approximately 1,000 to 4,000 ng/m^3 and 700 to 1,200 ng/m^3 in classrooms seven and 34-days after ballast failure, respectively.

Consider evaluating a hybrid approach between source modification (i.e., lowering the amount of PCBs in caulking through chemical degradation) and contact encapsulation (i.e., covering PCB-containing caulking with an impermeable sealant). Although both of these methods applied individually have documented limitations, in combination they may prove to be completely effective. Consider conducting efficacy trials for the sequential application of these methods. Performance over time and relevance to real-world conditions should be the focus of these trials.

3. **For each remedy: Does the remedy provide sufficient information to reasonably demonstrate the effectiveness of the proposed remedy? If not, what additional information is needed?**

    a. Fluorescent Light Ballast Response Protocol: A relatively simple and effective measure to reduce the air and surface burden of PCBs in the school buildings is upon awareness of a ballast failure (as characterized by "foul odor," smoke, and/or asphaltic potting compound dripping from the fixture) <u>immediately ventilate</u> the incident classroom and/or areas. The current protocol permits the PCB-borne vapor/particulate to remain in the room and disperse for up to 48 hours; i.e., the Department of School Facilities (DSF) will dispatch an environmental response contractor within 48 hours of the custodial engineer reporting the condition. It is recommended that the protocol be revised to require that the custodial engineer vacate the classroom or area (if applicable) and immediately open all windows in the room or area (if present) and take any measure available (such use of a fan) to vent the room air directly to the outdoors and replace it with fresh air.

        Mechanical ventilation of the space is paramount to minimizing dispersion of airborne PCBs and absorption of the particulate/vapor-borne PCBs on surfaces. The "Re-Occupancy Protocol for Ballast Fluid Leakage outside the Fixture and Visible Smoke Emissions from Ballast/s" (dated April 23, 2013) specifies that the incident room is ventilated by 20 complete air changes. Is there an objective basis for specifying 20 completed air changes? Is there any actual or empirical data or information that supports the effectiveness of the specified air exchange rate?

    b. Section 4.3.2 of the Best Maintenance Practice (BMP) regarding HVAC System states that the heating stacks will be used to provide tempered fresh outdoor air to the school buildings. The corresponding anticipated increase in the air-exchange rate for each school building should be calculated and included in the summary report. The positive impact of the increased volume of outdoor air on reducing the indoor air concentrations of PCBs should be determined to understand its effectiveness. The effectiveness of this remedial measure could be determined in a few pilot

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1 Kominsky, JR. PCB Contamination Resulting from Fluorescent Light Ballast Failure in Seattle Public Schools, NIOSH Report HETA-85-072-1980 (1987).

2 Kominsky, J.R. PCB Exposures Following Fluorescent Light Ballast Burnout. Applied Industrial Hygiene J. Vol. 2(3): R-23, 1987

buildings by collecting air samples both before and after using the heating stack to provide additional outdoor makeup air.

4. For each remedy: Are the methodologies used consistent with the state-of-science? If not, please provide specific references and suggestions for revision.

Yes, the methodologies used are consistent with the state-of-science, as applicable.

5. Do you have specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report?

I have no specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report other than included some concise data summary tables as an appendix to the report. This would afford the reader a better understanding of the report without accessing the source documents.

6a. Are there alternatives to the visual inspection protocol for detecting ballasts that have leaked?

Ballast burnout occurs when an electrical malfunction internal to the ballast (typically, a short circuit in the coil) causes a dramatic increase in internal temperature and ultimately ends with breaking the electrical circuit. The increased temperature causes the asphaltic potting compound in the ballast to melt and leak out. The odor associated with fluorescent light ballast burnout is typically associated with an odor that is characterized being “acrid,” “foul,” “electrical,”, or “burning asphalt.” Hence, detection of such an odor by a custodial engineer could be indicative of a recent or on-going electrical burnout of fluorescent light ballast.

The Preferred Citywide Remedy states the “T12 fixtures are inspected on a regular basis by custodial staff…” To ensure consistency by the Custodial Engineers to implement this action define the term “regular basis;” e.g., the T12 fixtures are inspected at least once per week or whatever frequency is feasible. State the basis for selecting the frequency for inspecting T12 fixtures.

6b. EPA has suggested revising the re-occupancy protocol to include post clean up air sampling in addition to the current practice of surface wipe sampling for PCBs. Is wipe sampling alone adequate to minimize exposure of students and staff to PCBs?

Electrical burnout of in service PCB-containing fluorescent light ballast release PCB-borne particulate/ vapor that deposits on surfaces in the incident classroom/area, as well as potentially on surfaces in other areas. The surface levels of PCBs (excluding surfaces directly impacted with asphaltic potting compound released from the fluorescent light ballast) range from non-detect (<0.1 µg/ 100 cm^2) to <3 µg/ 100 cm^2.[(1)] These surface contamination levels are higher than comparative background but are significantly lower than the U.S. EPA high occupancy surface wipe sample criteria (10 µg/ 100 cm^2). Hence, excluding the small isolated surfaces (e.g., desktop) directly impacted by potting compound that dripped from the fluorescent light fixture, the surfaces impacted by deposition of smoke particles in the room most likely will be consistently below the EPA occupancy surface criteria.

Air sampling in classrooms that experienced showed that Elevated levels (800 to 1,200 ng/m^3) of airborne PCBs existed 34-days after fluorescent light ballast burnout in classrooms.[(1)] Air sampling would be a better metric to determine potential exposure risk to the occupants from incidents involving visible smoke emissions from fluorescent light ballast burnout. Air sampling would also provide quantitative data to evaluate the adequacy of ventilating the classroom/area with 20 complete air changes as specified in the "Re-Occupancy Protocol for Ballast Fluid Leakage outside the Fixture and Visible Smoke Emissions from Ballast/s," dated April 23, 2013.

6c. If sampling for PCBs in air, is it possible to achieve a low enough detection limit (at least 50 ng/m^3) using a passive sampler?

Passive samplers that use polyurethane foam (i.e., PUF-PAS) are used indoors where high volume samplers are impractical; however, its ease of use is also coupled with uncertainty in calculating air concentrations from accumulated mass.[(3)] I am uncertain whether a PUF-PAS can consistently achieve a detection limit of $\leq$ 50 ng/m^3. Further, since the PUF-PAS is not an EPA or NIOSH validated sampling and analytical method for PCBs, I recommend using a traditional method (that is validated) and can consistently achieve a detection limit of 50 ng/m^3. These methods include EPA Method TO-10A (i.e., low volume PUF sampling, 1 to 5 liters per minute), and modified NIOSH Method 5503 (i.e., glass fiber filter and Florisil tube, 1 liter per minute).[(4)] At low PCB concentrations, the NIOSH method was found to be efficient when operated at a flow rates up to 1 L/min; under these conditions, the limit volume adjusted limit of detection was 20 ng/m^3.

6d. The approaches evaluated thus far include patch and repair, removal and encapsulation. Are there other approaches that may be evaluated?

Source modification (i.e., reduce the mass of PCBs in the source material such as caulk) individually or in combination with contact encapsulation should be considered. Chemical treatments of PCB-containing building materials include chemical degradation or extraction methods intended to reduce the PCB concentration of the source materials. Commercially available chemical degradation products are typically applied to sources as a slurry or paste, covered with an overlying material and left in place for days to weeks for the chemical reaction to occur. One dechlorination product has been reported to reduce PCB concentrations on various surfaces (such as railroad ballasts, soils and bulk oils) by 90 to 99%.[(5)] Its effectiveness on caulks and painted surfaces is being studied; the status of findings is not known. Another chemical degradation method, known as the Activated Metal Treatment System (AMTS), was developed by NASA.[(5)] The AMTS method eliminates PCBs by dechlorination and has been effective in removing PCBs from paint up to several thousand parts per million. Although the AMTS method was originally designed for painted surfaces, NASA reportedly also developed an improved method applicable to other sources such as caulks. Consider conducting studies to determine its effectiveness to remove PCBs from caulk in the school buildings.

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3 Persoon, C. and K. Hornbuckle. Calculation of Passive Sampling Rates from both Native PCBs and Depuration Compounds in Indoor and Outdoor Environments. Chemosphere 74(7):917-923 (2009).

4 Kominsky, JR. J. Applied Ind. Hyg. 1(4), R-6 (1986).

5 U.S. EPA. Literature Review of Remediation Methods for PCBs in Buildings. EPA/600/R-12/-34, January 2012.

Typically, source modification methods are employed as a precursor step to source contact encapsulation or as a follow-up step to bulk removal. Hence, a hybrid approach (i.e., source modification combined with contact encapsulation) should be considered and evaluated as an alternative methodology to source removal. In addition, the applicability and effectiveness of the hybrid methodology may vary with physical condition of the caulk. Caulk found on building exteriors is generally hard and brittle, whereas caulk found on interiors is often soft and flexible. Further, the concentrations of PCBs in the caulk may also vary from exterior to interior caulk.

6e. Should the caulk management plan address both deteriorated and intact caulk, or should it focus on only one condition of caulk?

Operations and maintenance (O&M) plans for PCBs in the school buildings should be a major component of the overall management plan to minimize exposure to PCBs by occupants of the school buildings. The O&M plan should include deteriorated and intact caulk with an emphasis on "deteriorated" caulk or caulk that is likely to be disturbed (either intentionally by planned construction activities or unintentionally by building occupants such as students). It is assumed that an inspection has been conducted in each of the school buildings to identify the location of the PCB-containing caulk by either chemical analysis or inference from homogeneous groups of materials.

O&M plans should address both primary and secondary source materials and concentrations, locations, conditions, accessibility, abatement and mitigation controls in place, inspections, work practices and controls for contacting and cleaning PCB source materials and the need for additional remediation actions. The O&M plan should also include provisions for periodic air and surface sampling to assess PCB concentrations and effectiveness of mitigation controls.

6f. The school buildings have been constructed over a period of more than a hundred years and many have been modified during the course of their operation. Air exchange rates under current operating conditions are unknown. Are there procedures, in addition to those specified in the collective bargaining agreement, which would minimize the impact of PCB releases?

Ventilation with outdoor air is a means of controlling concentrations of PCBs in indoor air from volatilization and/or PCB-bearing particulate independent of source removal or source modification.(5) The pilot study conducted in the three New York City school buildings [NYC DOE, 2010] showed ventilation to be effective for modifying indoor air concentrations and lowering exposures to building-related PCBs.

The procedures specified in Appendix F of the Collective Bargaining Agreement for Custodial Engineers relate to cleaning of equipment and not necessarily to performance of the HVAC equipment. The ventilation systems in each school building should be checked to ensure that it is functioning as designed or to applicable sections of ASHRAE Standard 62.1 such the minimum outdoor air rate (cubic feet per minute) per occupant or air exchange rates). Based on the evaluations make appropriate repairs to increase or improve the ventilation as necessary. Improvements or upgrades to existing ventilation system can be effective; however, the cost of heating and cooling outdoor air can be a practical constraint on implementation of this mitigation method.

6g. The proposal is to remove, replace and/or encapsulate caulk if disturbed during the course of routine construction projects. Would proactively addressing the presence of PCBs citywide, regardless of future construction, significantly reduce exposures? If so, what factors are recommended for consideration in identifying buildings that should be prioritized for caulk management activities (e.g., schools with passive ventilation systems, schools with children under 6)?

Proactively addressing the presence of PCBs in school buildings citywide through abatement (source removal and/or source modification), engineering controls (encapsulation, and/or ventilation, and/or air cleaning), and administrative controls (O&M Plan) will significantly lower exposures to PCBs. Intuitively school buildings with passive ventilation (i.e., rely on natural airflow through windows or other openings due to temperature and pressure differences) would be prioritized high for caulk management as well as PCB-containing fluorescent light ballast replacement.

To the extent that the available data (air, surface, soil, bulk material, etc.) permits, it is recommended that the data be analyzed to if there is any statistical relationship between air concentration and primary sources (caulk condition, frequency of ballast burnout), secondary sources (concentration in and/or painted surfaces), type of ventilation (mechanical and/or passive), and other factors. If such an analysis is not feasible, consider prioritizing the school buildings based on various factors. These factors include type of ventilation (passive ventilation = highest priority); estimated number of PCB-containing ballast and frequency of ballast burnout; estimated linear feet of PCB-containing caulk interior and exterior; PCB concentration in the caulk (emission rates are proportional to PCB concentration in caulk); and condition of caulk (higher priority caulk is that which is weathered, brittle, or deteriorating).

Points of clarification:

The intent of this recommendation is to identify any relationships between the primary route of exposure (i.e., inhalation of PCB-bearing particulate/vapor) and the principal factors that contribute (e.g., fluorescent lamp ballast burnout) to elevated air concentrations and decreased (e.g., mechanical and/or passive ventilation) air concentrations. That is, which factors have the greatest impact on increasing or decreasing the airborne concentrations of PCBs. This information would then be used to prioritize remedial measures with the intent of reducing inhalation exposures to PCBs. This recommendation is prompted because my review of the document did not show a clear basis for prioritizing the options of remedial measures.

The conceptual approach would be to identify (based on best engineering judgment) the factors, materials, and/or conditions that appear to have the greatest impact on the airborne concentrations of PCBs in the schools. Realizing of course; the factors, materials and/or conditions may vary with particular architectural characteristics and mechanical systems of the buildings, which may prompt grouping the buildings into homogeneous groups based on the similarity of these characteristics and systems. Once this is done the corresponding empirical data and measurement data (e.g., air concentrations) would then be reviewed to determine the most appropriate statistical approach, either using parametric or non-parametric statistical tests. I am sorry that I cannot more specific, but I am not sufficiently familiar with the empirical and measurement data to offer a more specific blueprint for the needed analysis to best prioritize the remedial approach.

6h. Would air sampling be an effective means of confirming a recommended prioritization scheme?

Yes, air sampling would be an effective means of confirming a recommended prioritization scheme. While building inspection data identifies the primary (e.g., caulking) and secondary (desorption from paint) sources of PCBs in the school buildings, the ultimate relative exposure risk in the school buildings is based on air concentrations; i.e., EPA's Public Health Guidance Values for PCBs in School Indoor Air. Air sampling data would integrate and quantitate the impact of the source materials to release PCBs through volatilization and as well as PCB-borne particulate due to deterioration and/or disturbance of a material. The effectiveness of air sampling to confirm the prioritization scheme is founded upon the design and implementation of the sampling strategy.

6i. The proposal is to evaluate soil for the presence of PCB following construction projects that might disturb exterior caulk. Would proactively evaluating the presence of PCBs in the soil at all schools with exterior PCB caulk, regardless of future construction, significantly reduce exposures?

Analysis by EPA of the soil samples collected from the five pilot schools P.S. 178 and 176 indicate the greater concentrations of PCBs were found at depth (5 to 10 cm) than were found in surface soil samples (0 to 5 cm) at locations <10 ft from the school building exterior. EPA concluded that the contamination resulted from disturbance of the in place caulking during historical construction activities and not due to release of caulking that flake off due to weathering. If this data is representative of the other school buildings it indicates that potential exposure from soil contamination may not be significant due to reduced accessibility to the contamination by soil cover. Further sampling should be conducted to verify this possibility.

The releasability of PCBs from the soil could be determined *in situ* using a RAFS technology[(6)] and the corresponding exposure concentration could be determined using a breathing zone model[(7)] developed with the RAFS technology. This technology was developed and validated under research contracts with EPA's Office of Research and Development (ORD), National Risk Management Research Laboratory in Cincinnati. The resultant RAFS data could be used to make risk-based decisions on the necessity for soil remediation at the exterior of the school buildings.

6j. Are there any perceive data gaps or limitations not identified by NYC?

The existing limitations and data gaps not identified by NYC include:

- Consider conducting additional studies to evaluate the efficacy of a hybrid approach of source modification plus contact encapsulation as an alternative methodology to source removal. That is, management in place vs. removal of the caulk unless the material will be directly affected by a construction activity; see item 6d.

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[6] Kominsky, J.R., J.W. Thornburg, G. Shaul, et al. *Development and Design of Releasable Asbestos Field Sampler*. J. Air & Waste Management Assoc. 60:294-301 (2010).

[7] Thornburg, J.W., J.R. Kominsky, G.G. Brown et al. A Model to Predict the Breathing Zone Concentrations of Particles Emitted from Surfaces. J. Environ. Monit. 12:973-980 (2010).

- Consider collection additional data to make risk-based decisions on the necessity for soil remediation at the exterior of the school buildings; see Item 6i.

Reviewer 3 Comments

External Letter Peer Review of Report on PCB Caulk in New York City School Buildings

Responses to Charge Questions by Reviewer 3

1. Does the Summary Report dated May 24, 2013 clearly and comprehensively describe the sources, environmental levels, and potential exposures for PCBs in school buildings?

The description of sources, environmental levels, and potential exposures for PCBs in school buildings presented in the Summary Report (the report) dated May 24, 20134 is written fairly clearly in that information is presented in sections that are of reasonable length and the language is accessible rather than heavy on technical jargon. Nonetheless, the clarity would be improved substantially if the report was organized differently and the language was more precise. At present, the report is organized in large part around three themes: (1) remedial actions, e.g., section 2.5; (2) types of sampling events, e.g., section 2.7; and (3) exposure interventions, e.g., section 2.8. This organization made it difficult for this reader to follow a 'thread' among the various sections of the report. As a result, the principal findings are not self-evident and in this sense the description of sources, environmental levels, and potential exposures is not clear at all. The clarity of the report would also be improved by adding more rigor to the descriptions of PCBs levels measured in exposure media. At present, the report most commonly provides the range of PCB concentrations measured during a sampling event. Additional information would be more informative, including measures of central tendency, such as the mean or median, and dispersion, such as the standard deviation. More information of this type is warranted given that the report makes a point of hypothesis testing in Section 2.1.2. In summary, the clarity of the report would be improved if organized in a consistent manner from section to section and if the report was more transparent about the quantitative findings from the large amount of sampling conducted.

The description of sources, environmental levels, and potential exposures for PCBs in school buildings presented in the report would need to be expanded in order to be comprehensive. Readers are provided with information on PCBs in caulk and selected other media, including dust and certain surface finishes. However, little information is provided on any other potential sources, primary or secondary, including but not limited to waterproofing materials, adhesives, ceiling tiles, or insulation. The authors describe the results of a secondary source strength analysis that apparently was conducted by EPA. The results of the secondary source strength analysis are presented with little discussion of the associated uncertainty and little evaluation of its accuracy through testing. A critical review, and probably empirical assessment, of remaining sources in the schools would be helpful if the City wished to obtain a deeper understanding of strategies for effectively mitigating current exposures. In addition, the report does not clearly state the scope of the work – e.g., is the report focused only on the pilot schools or instead does it cover the population of public schools in New York City. Clarifying the scope of the report would establish the benchmarks for evaluating the extent to which the document is comprehensive.

2. Please comment on the appropriateness of the remedies selected. Do they provide adequate reductions of the exposure to PCBs? If not, do you have suggestions for additional reductions that could be achieved, given the available data?

More information is needed to answer this question. An answer requires first determining exposures to PCBs that are acceptable in terms of magnitude, duration, and frequency. EPA has suggested benchmarks for concentrations of PCBs in indoor air and regulatory thresholds for PCBS in bulk materials and on surfaces. Those EPA benchmarks are reproduced in the report. However, this reviewer does not believe that the indoor air benchmarks have received a level of peer review that is typical of health protective guideline levels for chemical contaminants in environmental media established by EPA. Moreover, EPA recommends a site-specific analysis to support guideline values for a given building; site-specific analyses are not described in the report. Likewise, this reviewer does not believe the regulatory thresholds for bulk materials and surfaces are based on exposure scenarios for students, teachers, staff, and visitors in schools.

3. For each remedy: Does the remedy provide sufficient information to reasonably demonstrate the effectiveness of the proposed remedy? If not, what additional information is needed?

Caulk Patch and Repair. Yes. From experience and information, a patch and repair remedy is not likely to be effective at meeting applicable regulatory and normative benchmarks and this view is consistent with the findings described in the report.

Caulk Encapsulation. No. The report makes no mention of whether or not a barrier was placed between the PCB caulk and the encapsulant material. Published literature and personal experience indicate that encapsulation is a reasonably effective remedial measure when a barrier such as polyethylene tape is placed between PCB caulk and encapsulant material such as a Sikagard product.

Caulk Removal and Replacement. Yes. This method has been demonstrated to be ineffective elsewhere.

Window Replacement. No. This method can be effective at reducing exposures to a substantive degree when PCB caulk is present on the interior face of window frames. More information on the disposition of the caulk around window frames is needed to evaluate this remedial alternative more fully.

Light Fixture Ballast Removal and Replacement. Yes. This remedy removes a source of PCB emissions inside of schools and therefore is expected to be effective at controlling exposures to light ballast-related PCBs.

Best Management Practices. No. Testing of PCB levels in indoor air and on surfaces in schools that have been subject to Best Management Practices and comparison to performance benchmarks is needed to determine the effectiveness of this proposed remedy. At the time of this report, Best Management Practices appears to have been identified as a preferred remedy based upon deductive reasoning rather than through empirical means. The report and its conclusions would be strengthened by an analysis of the assumptions that underlie the Preferred Citywide Remedy and the extent to which those assumptions and the findings from the pilot schools can be applied to the population of schools in New York City. In addition, because the Best Management Practices do not include proactive interventions, expect for the light ballast and ventilation components, the report would be strengthened by presenting an analysis of the number of schools at risk of exposure concentrations in excess of health protective benchmarks and the length of time for which those conditions would be expected to persist under the Best Management Practices program.

Cleaning. Yes. From experience and information, a cleaning remedy is likely to have only limited effective at meeting applicable regulatory and normative benchmarks and this view is consistent with the findings described in the report.

Ventilation. No. There is no question that ventilation with outdoor air is an effective means of controlling concentrations of PCBs in indoor air of schools. The means by which outdoor air can be delivered to a building and the amount of outdoor air supplied is determined in large part by the ventilation schemes in use or otherwise available for a given building. A wide variety of strategies is possible, a subset of which may be applicable to a given school. The report would need to include a matrix of ventilation modes in New York City schools and the corresponding ventilation strategies in order for the proposed remedy to be sufficient.

Carbon Filtration. No. The remedy would need to include specific carbon filtration devices and replacement schedules to be sufficient. This information is important in order to address the inherent limitations of strategies based on sorbent media which include but are not limited to capacity and fouling by ubiquitous substances such as water vapor.

Exterior Sources. Yes. From experience and information, remediation of soil is an effective means of controlling PCB levels in soil and this view is consistent with the findings described in the report.

Additional Comments. See prior responses regarding controlling for effects of temperature and ventilation when evaluating the efficacy of remedies for mitigating PCB concentrations in indoor air.

4. For each remedy: Are the methodologies used consistent with the state-of-science? If not, please provide specific references and suggestions for revision.

To evaluate the efficacy of remedies for controlling indoor air concentrations of PCBs, investigations should account for effects of temperature on PCB emissions and ventilation on removal of airborne PCBs. Methods for temperature and ventilation control are described in the open literature (e.g., MacIntosh et al. 2012). The report makes no mention of controlling for temperature and ventilation quantitatively when comparing pre- and post-remediation air sampling results. Without controlling the indoor air sampling results for effects of temperature and ventilation, the robustness of the conclusions about the effectiveness of specific remedies for mitigating inhalation exposures is unknown.

Additionally, see responses to the preceding question.

5. Do you have specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report?

The report would be more clear and comprehensive if it provided information on the amount of interior PCB caulk in each school – e.g., length, width, exposed area, weight, and coating (if any). Inclusion of photographs would be helpful for providing readers with the context needed to understand the disposition of PCB containing materials in the schools.

The report would be stronger if expanded to clarify the PCB exposure benchmarks used to evaluate success of any given remedy or combination of remedies. A rationale and justification for the benchmarks should be provided.

See above for other specific recommendations.

Below (in blue font) are elements of the proposed Preferred Citywide Remedy taken from the Executive Summary. Charge questions 6a through 6j are specific to those portions of the remedy.

6a. Are there alternatives to the visual inspection protocol for detecting ballasts that have leaked?

Yes. Air testing is an alternative to the visual inspection protocol. Air testing has the advantage of integrating emissions from all potential light ballast sources and therefore does not rely upon the ability of inspectors to identify evidence of a leak. Air testing would also detect emissions from sources other than light ballasts. The approach is therefore sensitive, but not specific. The report would be strengthened if the City articulated the relative weight or value it places on sensitivity versus specificity for the proposed and all alternative light ballast remedies.

6b. EPA has suggested revising the re-occupancy protocol to include post clean up air sampling in addition to the current practice of surface wipe sampling for PCBs. Is wipe sampling alone adequate to minimize exposure of students and staff to PCBs?

If conducted appropriately, wipe sampling following clean up of surfaces that contained residual PCBs released from light ballasts should be sufficient for ensuring that exposures to light ballast-related PCBs identified by the visual inspection program are minimized. An appropriate wipe sampling program would be representative of the surfaces known or suspected to have contained light ballast-related PCBs.

However, such a program may not be sufficient for ensuring that all PCB exposures associated with light ballast releases are minimized. For example, PCBs released from light ballasts are likely to migrate to other materials in a building as a result of volatilization and subsequent sorption. Those secondary source materials could lead to exposures that exceed City-specified exposure thresholds and therefore would warrant mitigation.

Similarly, wipe sampling areas that formerly contained stains consistent with PCB oil from light ballasts would not be sufficient for minimizing exposures to PCB released from other sources, such as interior caulk. This point is mentioned because Question 6b is not specific about the source of PCBs to which the wipe sampling is directed. The question as phrased is silent on the sources of interest. Thus, if the question pertains to PCB exposures regardless of source, then wipe sampling alone is not likely to be adequate for minimizing exposure of students and staff to PCBs. In that case, air sampling in addition to wipe sampling would be a more comprehensive approach.

6c. If sampling for PCBs in air, is it possible to achieve a low enough detection limit (at least 50 ng/m^3) using a passive sampler?

Passive sampling techniques for PCBs (and other semi-volatiles) are described in the literature. The advantages and disadvantages of passive sampling in comparison to active sampling should be explored before deciding to adopt a passive sampling approach. Other criteria to consider include labor time and cost, laboratory costs, validity, representativeness, accuracy, and precision.

6d. The approaches evaluated thus far include patch and repair, removal and encapsulation. Are there other approaches that may be evaluated?

See preceding responses with respect to the use of polyethylene tape as part of an encapsulation remedy. In addition, NYC should consider covering interior PCB-containing caulk with physical barriers such as gypsum board and aluminum strips rather than simply encapsulation. These methods have been demonstrated to be effective elsewhere.

6e. Should the caulk management plan address both deteriorated and intact caulk, or should it focus on only one condition of caulk?

The caulk management plan should focus on all forms of caulk that contain PCBs at percent level concentrations. A focus on deteriorated caulk only would not fully account for vapor phase emissions of PCBs from intact caulk, a very important emission pathway.

6f. The school buildings have been constructed over a period of more than a hundred years and many have been modified during the course of their operation. Air exchange rates under current operating conditions are unknown. Are there procedures, in addition to those specified in the collective bargaining agreement, which would minimize the impact of PCB releases?

See preceding comments with respect to ventilation.

6g. The proposal is to remove, replace and/or encapsulate caulk if disturbed during the course of routine construction projects. Would proactively addressing the presence of PCBs city-wide, regardless of future construction, significantly reduce exposures? If so, what factors are recommended for consideration in identifying buildings that should be prioritized for caulk management activities (e.g., schools with passive ventilation systems, schools with children under 6)?

Proactively addressing the presence of PCBs city-wide, regardless of future construction has the potential to significantly reduce exposures, especially in schools with interior caulk that contains PCBs at percent concentrations and/or buildings with sub-standard ventilation conditions. The City could consider factors such as type of construction, amount of interior caulk, type of ventilation system, and information on energy intensity for heating and cooling to prioritize caulk management activities.

6h. Would air sampling be an effective means of confirming a recommended prioritization scheme?

Yes, but only if done according to state-of-the-art methods for analysis and interpretation of the data, as well as ensuring that the sampling is representative, and used to support decisions that reflect site-specific performance benchmarks.

6i. The proposal is to evaluate soil for the presence of PCB following construction projects that might disturb exterior caulk. Would proactively evaluating the presence of PCBs in the soil at all schools with exterior PCB caulk, regardless of future construction, significantly reduce exposures?

Unlikely. Rates of exposure to PCBs associated with building-related PCB levels in soil are typically very low in comparison to PCBs exposures that arise from anthropogenic background PCBs levels in environmental media and in indoor air of buildings with interior sources of PCB emissions. As such, proactive evaluation of PCBs in soil would likely yield a negligible exposure benefit in the opinion of this reviewer.

6j. Are there any perceived data gaps or limitations not identified by NYC?

See responses to the preceding questions. In addition, this reviewer strongly recommends an analysis of the value of information gained from any additional studies. Managing building-related PCBs in schools is an important municipal activity. In practical situations like this one, questions are generally valuable to answer only when the answer(s) has the potential to result in a change of course or action. The value of information from the additional studies mentioned is not demonstrated in the report. This lack of information is a data gap in the opinion of this reviewer.

The report should explain why the Preferred Citywide Remedy does not include air sampling in New York City schools constructed during the period when PCB-containing building materials were in commerce. EPA guidance recommends air testing when information on potential exposures is desired. Moreover, the pilot study demonstrates that PCB levels in some schools, at some times, can be well above the public health targets for PCB exposure concentrations in indoor air provided by EPA. The absence of discussion of the contrast between the BMP plan and EPA guidance is a gap in the report. Adding such a discussion has the potential to improve the clarity of the report and to strengthen the conclusions.

Applicable References

MacIntosh et al., 2012. Mitigation of building-related PCBs in indoor air of a school. Environmental Health. 11:24. http://www.ehjournal.net/content/11/1/24

EPA. 2012. Literature review of remediation methods for PCBs in buildings. U.S. Environmental Protection Agency, National Risk Management Laboratory. Prepared by Environmental Health & Engineering, Inc., Needham, MA. http://nepis.epa.gov/Adobe/PDF/P100FA8L.pdf

Appendix B: Charge to Reviewers

Technical Charge to External Peer Reviewers
Contract No. EP-C-12-029
Task Order 23
November 2013

External Letter Peer Review of Report on PCB Caulk in New York City School Buildings

BACKGROUND

Polychlorinated biphenyls, or PCBs, are man-made chemicals that persist in the environment and were widely used in construction materials and electrical products prior to 1978. Although Congress banned the manufacture and most uses of PCBs in 1976 and they were phased out in 1978, there is evidence that many buildings across the country constructed or renovated from 1950 to 1978 may have PCBs in the caulk used in interior and exterior locations, sometimes at high concentrations. Other sources of PCBs, such as fluorescent light ballasts, adhesives, paints, and mastic may also be present in buildings. Exposure to these PCBs may occur as a result of their release into the air, dust, surrounding surfaces and soil.

The PCBs in caulk, adhesives, paint and mastic (that are at levels greater than or equal to 50 ppm) are not authorized for use under the Toxic Substances Control Act (TSCA). While TSCA regulations do not require building owners to test for PCBs, if testing of these building materials shows PCB concentrations at or above 50 ppm then the PCBs must be properly disposed of, in accordance with 40 CFR 761.62. The PCBs in non-leaking, intact ballasts are an authorized use and may be disposed of in a properly permitted solid waste landfill. Ballasts containing PCBs which have leaked must be disposed of in a properly permitted hazardous waste landfill or incinerator. Materials contaminated by PCBs that have leaked or migrated from the aforementioned regulated building materials must be disposed of in accordance with 40 CFR 761.61.

New York City (NYC) has conducted a remedial investigation/feasibility study at 5 NYC schools to evaluate alternative means of dealing with PCB-containing caulk in their schools. The investigation has demonstrated that the PCB-containing caulk is but one of several PCB sources. Emissions of PCBs from caulk and leaking ballasts in light fixtures have also contaminated a wide range of other building materials, which may be re-emitting PCBs into the air. It has also been demonstrated that many areas in the schools are inadequately ventilated.

EPA Research Results

EPA scientists have been using the data collected by NYC and data collected by EPA contractors to better understand exposures to children, teachers, and other school workers. EPA is also investigating methods to reduce or eliminate PCB emissions in a school setting. EPA's webpage (http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/caulk/caulkresearch.htm) highlights the following research results about PCBs in schools and contains links to additional information:

- Caulk put in place between 1950 and 1979 may contain as much as 30% PCBs and can emit PCBs into the surrounding air. PCBs from caulk may also contaminate adjacent materials such as masonry or wood.
- Fluorescent lighting fixtures that still contain their original PCB-containing light ballasts have exceeded their designed lifespan, and the chance for rupture and emitting PCBs is significant. Sudden rupture of PCB-containing light ballasts may result in exposure to the occupants and may also result in the addition of significant clean-up costs.

- Some building materials (e.g., paint and masonry walls) and indoor dust can absorb PCB emissions and become potential secondary sources for PCBs. When the primary PCB-emitting sources are removed, the secondary sources often emit PCBs.
- Encapsulation is a containment method that uses a coating material to separate PCB sources from the surrounding environment to reduce surface and air concentrations of PCBs. Encapsulation is only effective at reducing air concentrations to desirable levels when the PCB content in the source is low. Selecting high-performance coating materials is key to effective encapsulation. Multiple layers of coatings enhance the performance of the encapsulation.

EPA has calculated prudent public health levels that maintain PCB exposures below the "reference dose" – the amount of PCB exposure that EPA does not believe will cause harm. EPA's reference dose (RfD) is 20 ng PCB/kg body weight per day. Indoor air levels are based upon EPA's understanding of average exposure to PCBs from all other major sources, and were calculated for all ages of children from toddlers in daycare (70 ng/m3) to adolescents in high school (600 ng/m3) as well as for adult school employees (450 ng/m3). Attempts to achieve these risk-based goals for PCBs in schools will potentially involve balancing removal or containment of the PCBs in caulk, light fixtures, secondarily contaminated materials, and improvements in ventilation.

PURPOSE

Approximately 1 million school children are exposed to PCBs from caulk, light fixtures, and secondarily contaminated materials. The removal and replacement of the light fixtures alone from approximately 750 NYC public schools has been estimated by NYC to cost approximately 800 million dollars. Given the large stakes involved, it is important that the best long-term solutions are identified and implemented.

The Consent Agreement and Final Order between EPA Region 2 and the City of New York and the NYC School Construction Authority (SCA) requires that EPA "convene an independent peer review panel to evaluate the effectiveness of the recommended Preferred Citywide Remedy, as well as supplements or modifications proposed for consideration by EPA, and to make recommendations for appropriate modifications". Therefore, the purpose of this letter review is to evaluate the effectiveness of the Preferred Citywide Remedy as presented in the *Summary Report for the New York City School Construction Authority Pilot Study to Address PCB Caulk in New York City School Buildings* (Summary Report.pdf), prepared by TRC Engineers (referred to as the "Summary Report"). Additionally, the Re-Occupancy Protocol currently used by the Department of Education when a ballast failure occurs (Reoccupancy Protocol Outside.pdf) is a component of the "Interim Visual Inspection and PCB Response Action Program" remedy and should be evaluated as part of that remedy.

The following five documents are being provided for background purposes. They are not part of this peer review:

- Feasibility Study for the New York City School Construction Authority Pilot Study to Address PCB Caulk in New York City School Buildings (Feasibility Study.pdf)
- Final Remedial Investigation Report Pilot Study to Address PCB Caulk in NYC School Buildings (Remedial Investigation Report.pdf)
- The NYC collective bargaining agreement with the International Union of Operating Engineers (CBA.pdf)
- EPA comments on the Re-Occupancy Protocol (Chancellor Walcot Letter on Reoccupancy Protocol.pdf)
- Kathleen Grimm response to EPA comments on the Re-Occupancy Protocol (Grimm Response.pdf)

GENERAL INSTRUCTIONS

- Read ERG's Letter of Instruction.
- Read the technical charge questions.
- Respond to the charge questions in the same order as presented below.
- Explain and justify the rationale for your responses to the charge questions (a simple yes or no response is not acceptable).
- If a question is outside your area of expertise, please indicate this as your response.
- Please follow the *Review Guidelines* and *Formatting Instructions* on page 6 of this charge.
- Per your signed consulting agreement with ERG, maintain strict confidentially regarding all peer review materials, including your written comments, and do not share or distribute them to anyone except ERG.

CHARGE QUESTIONS

Please provide comprehensive comments with your answers to each of the questions below, including your reasoning for the specific answer/response and any suggestions for improvements.

1. Does the Summary Report dated May 24, 2013 clearly and comprehensively describe the sources, environmental levels, and potential exposures for PCBs in school buildings?

2. Please comment on the appropriateness of the remedies selected. Do they provide adequate reductions of the exposure to PCBs? If not, do you have suggestions for additional reductions that could be achieved, given the available data?

3. For each remedy: Does the remedy provide sufficient information to reasonably demonstrate the effectiveness of the proposed remedy? If not, what additional information is needed?

4. For each remedy: Are the methodologies used consistent with the state-of-science? If not, please provide specific references and suggestions for revision.

5. Do you have specific recommendations for clarification, explanation, or analysis of data, results, conclusions or other information included in this report?

6. Below (in blue font) are elements of the proposed Preferred Citywide Remedy taken from the Executive Summary. Charge questions 6a through 6j are specific to those portions of the remedy.

    - **PCB Ballast and Associated Light Fixture Management and Replacement -** The City will continue to implement its ongoing program whereby all light fixtures that use or used PCB ballasts and associated light fixtures in New York City public school buildings are removed and replaced on a prioritized basis. All light fixture replacements projects will be completed by December 31, 2016. *(No specific questions related to this portion. The timeframe is the result of a court settlement.)*

    - **Interim Visual Inspection and PCB Response Action Program:** The City will also continue its program whereby T12 lighting fixtures (which may contain PCB ballasts) are inspected on a regular basis by custodial staff for evidence of brownish black residue on any of the following: light diffuser (lens), light housing, or any area directly below lighting fixtures (furniture or floor). If leaks are observed, the fixture and the intact ballast or the ballast alone (if only the ballast has PCBs and there are no stains on the fixture) is removed by an electrician. Finally, procedures are in place and will continue to be implemented for the limited cases when PCB ballast leakage occurs outside the fixture (housing or diffuser) or when smoke is emitted from ballasts. This procedure includes the expedited removal of the ballasts and/or fixtures, aggressive ventilation, and cleaning or removal and disposal of any additional impacted items, with confirmatory wipe sampling for PCBs. Both protocols are annexed hereto and would be interim components of the preferred remedy.

6a. Are there alternatives to the visual inspection protocol for detecting ballasts that have leaked?

6b. EPA has suggested revising the re-occupancy protocol to include post clean up air sampling in addition to the current practice of surface wipe sampling for PCBs. Is wipe sampling alone adequate to minimize exposure of students and staff to PCBs?

6c. If sampling for PCBs in air, is it possible to achieve a low enough detection limit (at least 50 ng/m^3) using a passive sampler?

- **Continued Assessment with EPA on Potential Caulk Remedial Measures:** While the measures thus far evaluated in the Pilot Study have yet to yield an effective remedy for PCB caulk, the work performed during the pilot study has yielded invaluable data and information on potential remedial measures designed to address this complex issue. As part of the preferred remedy, the City would like to continue this work under EPA's oversight by performing evaluations of new remedial approaches for PCB caulk. The City would perform this work in schools where fixtures containing PCB light ballasts have already been removed.

6d. The approaches evaluated thus far include patch and repair, removal and encapsulation. Are there other approaches that may be evaluated?

- **Best Management Practices -** The Best Management Practices (BMP), as approved by EPA in April 2012, will be implemented. This includes employing strategies for managing PCB caulk and ensuring safe and proper operation of all heating, air conditioning, ventilating and similar equipment (collectively "HVAC").

  – **PCB Caulk Management-** Measures and practices will be used to protect interior and exterior PCB caulk from accidental damage and to identify the potential for deterioration through routine inspections requiring further action on an ongoing basis during school maintenance, repair and renovation. The BMPs also reference remediation of deteriorated PCB caulk by removal and replacement, patch and repair, or encapsulation.

6e. Should the caulk management plan address both deteriorated and intact caulk, or should it focus on only one condition of caulk?

  – **Heating Ventilating and Air Conditioning Maintenance** Building Air exchange rates will be maintained per design by ensuring that the HVAC and general ventilation systems are operating properly in accordance with the requirements contained in Appendix F of the Collective Bargaining Agreement. HVAC and general ventilation supply and exhaust fans will be operated while schools are occupied. Heating stacks, where designed primarily for ventilation rather than heating, shall be used to provide tempered fresh air while buildings are occupied. The City will maintain, adjust and make minor repairs to systems as needed. If there are problems identified with the systems that are beyond the ability of the appropriate building staff to directly rectify, a work request will be submitted on an expedited priority of a time sensitive nature.

6f. The school buildings have been constructed over a period of more than a hundred years and many have been modified during the course of their operation. Air exchange rates under current operating conditions are unknown. Are there procedures, in addition to those specified in the collective bargaining agreement, which would minimize the impact of PCB releases?

- **Removal, Replacement and Encapsulation of Caulk -** As presented in the BMP, capital projects to renovate schools will be performed by the New York City School Construction Authority (SCA) in accordance with standard construction specifications which have been developed to properly manage and dispose of PCB caulk when it is disturbed during renovation activities. These protocols require rigorous dust control measures during the work followed by cleaning and inspection at the conclusion of every work shift to minimize the potential exposure to PCB-containing dust during construction.

6g. The proposal is to remove, replace and/or encapsulate caulk if disturbed during the course of routine construction projects. Would proactively addressing the presence of PCBs city-wide, regardless of future construction, significantly reduce exposures? If so, what factors are recommended for consideration in identifying buildings that should be prioritized for caulk management activities (e.g., schools with passive ventilation systems, schools with children under 6)?

6h. Would air sampling be an effective means of confirming a recommended prioritization scheme?

- **Soil Evaluation, Excavation and Replacement -** SCA will evaluate the presence of PCBs in the surface soil within outside exposure areas (i.e., soil within ten feet of the building face), following the completion of construction projects that disturb exterior PCB caulk. Any surface soil within ten feet of the building found to contain PCBs at a concentration of greater than the 1 ppm guidance value will be the subject of remediation by excavation and off-site disposal. Confirmatory post-excavation soil results will be obtained. After removing contaminated soil, the excavation will be backfilled using clean fill.

6i. The proposal is to evaluate soil for the presence of PCB following construction projects that might disturb exterior caulk. Would proactively evaluating the presence of PCBs in the soil at all schools with exterior PCB caulk, regardless of future construction, significantly reduce exposures?

- **Public Outreach -** The City will implement public outreach pursuant to Local Laws 68 and Local Laws 69 of 2011 (see Appendix A). In addition, the City shall continue to maintain its updated website, which provides email updates to those who request such notices. The website will, among other things, provide information on the City's progress to remove PCB light fixtures. (*No specific questions related to this portion. These are terms of the CAFO.)*

- Finally, due to existing limitations and data gaps associated with managing PCBs in school buildings additional studies are recommended in the areas of long-term monitoring, encapsulation of caulk and substrate, and activated carbon air filtration. It is anticipated that the proposed approach to managing PCBs in the schools will be subject to change based on future data collection and data evaluation.

6j. Are there any perceived data gaps or limitations not identified by NYC?